Section 206 Program
Detailed Project Report/Environmental Assessment

DRAFT FOR PUBLIC REVIEW

Run Pond, Coastal Wetland Restoration Project
Yarmouth, Massachusetts

September 2008

US Army Corps
of Engineers

New England District

RUN POND COASTAL WETLANDS RESTORATION PROJECT
YARMOUTH, MASSACHUSETTS

DETAILED PROJECT REPORT/ENVIRONMENTAL ASSESSMENT

DRAFT FOR PUBLIC REVIEW

Aquatic Ecosystem Restoration
(Section 206 – WRDA 1996)

September 2008

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

EXECUTIVE SUMMARY

This report documents the feasibility investigation conducted to examine restoration of salt marsh and salt pond habitat at Run Pond, in Yarmouth, Massachusetts. This study was conducted by the U.S. Army Corps of Engineers (Corps) at the request of the town of Yarmouth, Massachusetts.

This report also serves as the Environmental Assessment (EA) for the proposed project. Preparation of the EA complies with the Council of Environmental Quality and U.S. Corps regulations for implementing the National Environmental Policy Act of 1969.

Authorization for this study is provided under Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303), as amended. This legislation provides authority to the Corps to implement aquatic ecosystem restoration and protection measures if the project will improve environmental quality, is in the public interest, and is cost effective.

The proposed project will increase tidal exchange to about 30 acres of coastal wetland at an estimated total project cost of $4,180,000 (including study and design costs). The primary feature of the proposed project consists of installing an additional 900 ft. long 48-inch diameter culvert to augment the existing culvert from the ocean to the Run Pond wetland. The existing 36-inch diameter culvert is located under the town's public parking lot near the Bass River. The new culvert will be placed near the existing culvert and will be used in addition to the existing culvert to convey tidal flows to Run Pond and salt marsh. The project will include tide gates on the culverts to provide for flow control during storm tides, creation of a depression in the pond as a fish refuge during low tide (about 0.4 acres), construction of a fringing wetland (about 0.3 acres), and eradication of *Phragmites*.

Habitat value analysis indicated that the project would yield 38.9 habitat units compared to 20 habitat units for the no action alternative. This represents a doubling of the habitat value at the site. The increased value is in the benthic, fisheries, and waterfowl habitat components. The project will result in increased tidal exchange and will improve water quality and increase salinity.

FINDING OF NO SIGNIFICANT IMPACT

Run Pond, Coastal Wetland Restoration Project
Yarmouth, Massachusetts

The proposed Federal action involves the restoration of approximately 30 acres of wetland in Run Pond, Yarmouth, Massachusetts. The proposed project involves installation of about 900 ft. of new 48-inch diameter culvert to supplement flow through the existing 36" diameter culvert to increase tidal exchange. The new culvert would extend from a new headwall north of South Shore Drive through the town public parking area to the outlet near Bass River.

The existing channel upstream of the Run Pond headwall would be excavated and widened to about 50 ft. for a distance of about 100 feet upstream of the headwall. About 700 cubic yards (CY) of silty-sand material would be excavated from the channel area. The lower 315 feet of the existing culvert would be replaced with a new 36" diameter culvert parallel to the new 48" culvert to the outlet near Bass River.

The proposed plan includes construction of a shallow depression near Shore Drive (0.4 acres) at the southern end of the pond. The depression would provide a refuge for fish and other aquatic life during low tide when much of the pond bottom will be exposed. About 0.3 acres of vegetated salt marsh would be constructed at the southern end of the pond using material excavated from the depression. The proposed plan also includes eradication of *Phragmites* with herbicide and excavation of small ditches within vegetated wetlands to improve tidal exchange and promote growth of salt marsh vegetation.

The proposed plan includes self-adjusting tide gates to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond. It also includes adjustable stop logs to allow some surface water to be retained within the pond during low tide.

Work is authorized under Section 206 of the Water Resources Development Act of 1996 (WRDA), as amended. The project will benefit benthic, fish and waterfowl habitat. I find that based on the evaluation of environmental effects discussed in this document, the decision on this application is not a major federal action significantly affecting the quality of the human environment. Under the Council on Environmental Quality ("CEQ") NEPA regulations, "NEPA significance" is a concept dependent upon context and intensity (40 C.F.R. § 1508.27.) When considering a site-specific action like the proposed project, significance is measured by the impacts felt at a local scale, as opposed to a regional or nationwide context. The CEQ regulations identify a number of factors to measure the intensity of impact. These factors are discussed below, and none are implicated here to warrant a finding of NEPA significance. A review of these NEPA "intensity" factors reveals that the proposed action would not result in a significant impact—neither beneficial nor detrimental--to the human environment.

<u>Impacts on public health or safety</u>: The project is expected to have no effect on public health and safety.

<u>Unique characteristics</u>: Coastal salt ponds such as Run Pond are a unique and highly valued resource. By improving the connectivity with the ocean the proposed project will improve water and habitat quality.

<u>Controversy</u>: The proposed project is not controversial. State and Federal resource agencies agree with the Corps impact assessment.

<u>Uncertain impacts</u>: The impacts of the proposed project are not uncertain, they are readily understood based on past experiences the Corps has had with similar projects.

<u>Precedent for future actions</u>: The proposed project is authorized under an existing federal law (WRDA) and will not establish a precedent for future actions.

<u>Cumulative significance</u>: As discussed in the EA, to the extent that other actions are expected to be related to project as proposed, these actions will provide little measurable cumulative impact.

<u>Historic resources</u>: The project will have no known negative impacts on any pre-contact archaeological sites recorded by the State of Massachusetts. An archaeological investigation will be conducted on any undisturbed areas within the existing wetland fringes on the Run Pond side of South Street prior to final design of the culvert head wall in this area. If any sites are discovered, action will be taken to avoid, minimize or mitigate any identified resources. These activities

will be coordinated with the Massachusetts State Historic Preservation Officer and Wampanoag Tribal Historic Preservation Officer in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and implementing regulations 36 CFR 800.

<u>Endangered species</u>: The project will have no known positive or negative impacts on any State or Federal threatened or endangered species.

<u>Potential violation of state or federal law</u>: This federal action would not violate federal or state law.

Measures to minimize adverse environmental affects of the proposed action are discussed in Section 6 of the EA. These include measures to minimize sedimentation and turbidity and seasonal restrictions. Construction will not occur during the summer. During the summer, shellfish, other benthic organisms, and finfish are spawning and biological activity is highest. In addition, during this time the parking area at the town beach is heavily used for recreational purposes. Avoiding summer construction will minimize biological impacts and avoid recreational impacts.

Based on my review and evaluation of the environmental effects as presented in the Environmental Assessment, I have determined that the Run Pond Coastal Wetland Restoration Project is not a major Federal action significantly affecting the quality of the human environment. Therefore, I have determined that this project is exempt from requirements to prepare an Environmental Impact Statement.

____________________	________________________
Date	Philip T. Feir Colonel, Corps of Engineers

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ACRONYMNS AND ABBREVIATIONS

ACOE	Army Corps of Engineers
AWQC	Ambient water quality criteria
BMPs	Best Management Practices
cfs	Cubic feet per second
cy	Cubic yard
DEP	Department of Environmental Protection (Massachusetts)
DO	Dissolved oxygen
EA	Environmental Assessment
EPA	United States Environmental Protection Agency
EJ	Environmental Justice
FONSI	Finding of No Significant Impact
ft.	Feet
mg/kg	Milligram/kilogram (= ppm)
mg/l	Milligram/liter (= ppm)
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Policy Act
NGVD	National Geodedic Vertical Datum
NRCS	Natural Resources Conservation Service
NOx	Nitrous oxides
PAHs	Polynuclear aromatic hydrocarbons
PEC	Probable Effects Concentration
PCBs	Polychlorinated biphenyls
Ppt	Parts per thousand
USGS	United States Geological Survey

1.0 INTRODUCTION

1. 1 Location

The Run Pond Coastal wetland restoration site is located in the Town of Yarmouth, Massachusetts, in Barnstable County on Cape Cod (Figure 1). For purposes of this report, the site will be called Run Pond. It is also known as Crowell Pond. It is next to the Bass River. The salt marsh/pond complex is bounded by Willow Street on the north, South Street on the east, South Shore Drive on the south, and Run Pond Road on the west. The site is in the 10th Massachusetts Congressional District.

1.2 Authority

This project is authorized under Section 206 of WRDA 1996, P.L. 104-303, as amended. Section 206 provides programmatic authority for the Corps to carry out aquatic ecosystem restoration projects that improve the quality of the environment, are in the public interest, and are cost effective.

1.3 Problem Description

The Run Pond coastal marsh and salt pond complex (about 30 acres) is impacted because of restricted tidal exchange. Historically a meandering tidal creek connected the site to the Nantucket Sound. About 1950 the open tidal creek was placed in a culvert and the area was paved to provide a needed parking area for the town beach.

Natural tidal flushing of the salt pond and marsh is restricted by the limited capacity of the existing 900 ft. long culvert. The culvert restricts the water level fluctuation in the marsh to less than half a foot under spring tide conditions. Under the same conditions, the open water tide fluctuates approximately 4 feet. The fringing salt marsh shows signs of degradation including the spread of *Lythrum salicaria* (purple loosestrife) and *Phragmites australis* (common reed) into the formerly *Spartina*-dominated salt marsh. Because of the reduced tidal flushing and nutrient influx to the pond, the pond experiences extensive alga blooms in the summer. These blooms result in diurnal swings in dissolved oxygen in the pond and evening dissolved oxygen depletions. Observed dissolved oxygen levels in the early morning were well below water quality standards. If nothing is done to improve flow conditions at the site, it is expected that the area will continue to degrade and valuable coastal wetland habitat will be lost. Photographs of the project site are included on the next page.

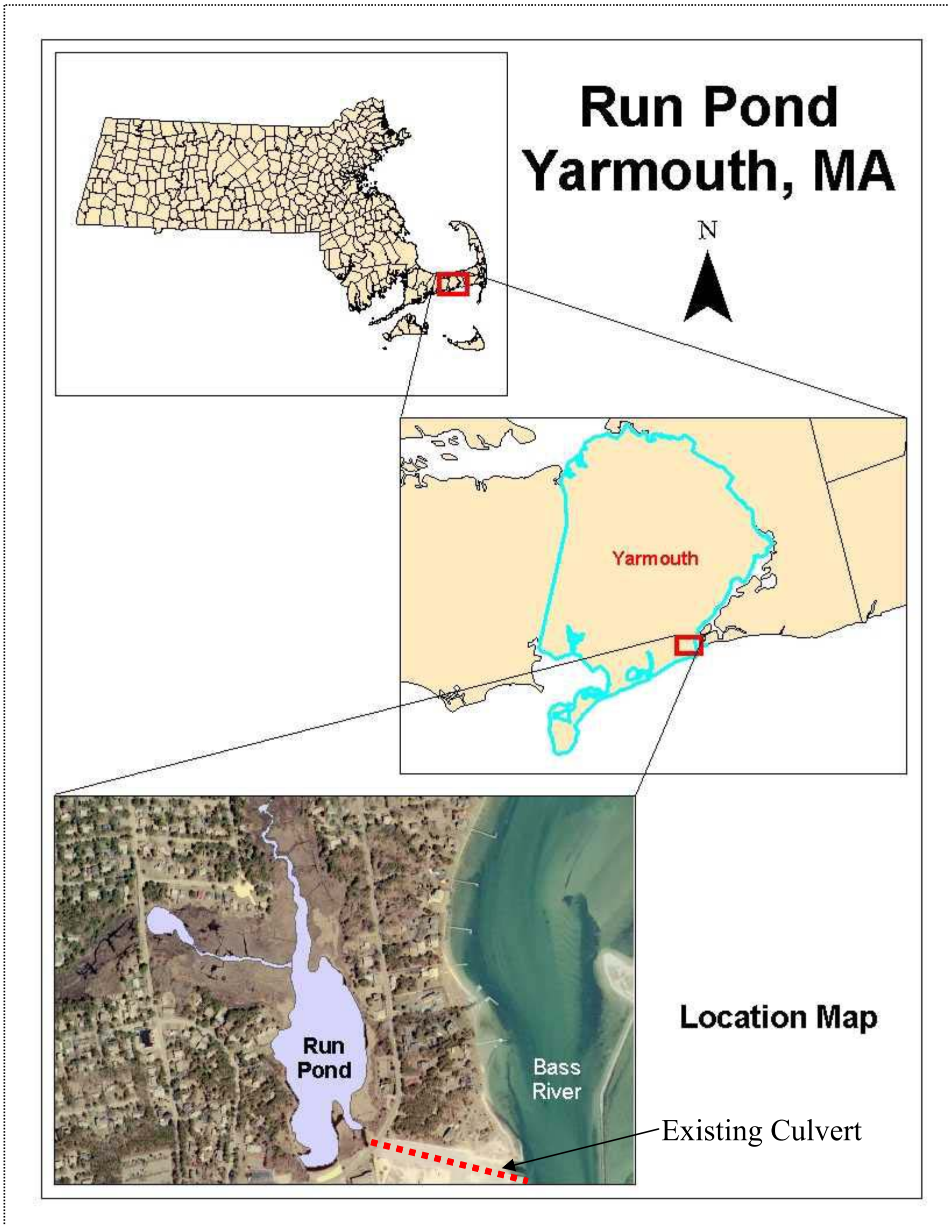

Run Pond
Yarmouth, MA
N
Yarmouth
Location Map
Run
Pond
Bass
River
Existing Culvert

Figure 1


Photograph 1: Run Pond


Photograph 2: Phragmites encroaching into salt marsh vegetation.


Photograph 3: Town beach parking lot.


Photograph 4: Existing culvert at Run Pond.

2.0 AFFECTED ENVIRONMENT

2.1 Land Use

Historic topographic maps and aerial photographs were reviewed to document previous site conditions and any apparent land use changes at the site over time. From this review, it is clear that the characteristics of the area have changed a lot since the late 1890's to present.

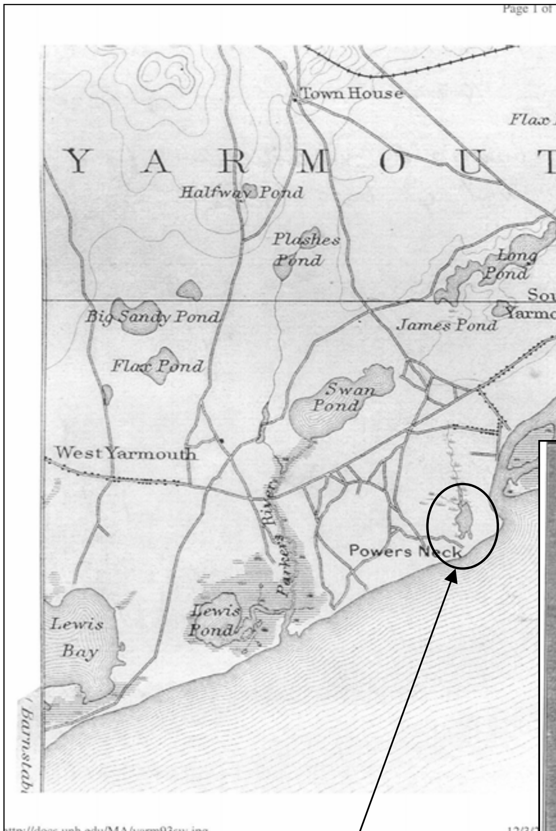
The 1893 USGS 15 min quadrangle for Yarmouth shows Run Pond as a coastal pond with no connection to the Bass River or Nantucket Sound (Figure 2). At this time, the pond probably functioned as a true coastal salt pond, with only occasional surface flow to Nantucket Sound during high water events. The pond shoreline was largely undeveloped.

<u>December 14, 1938 aerial photograph (see Figure 2)</u>. Photograph shows an open channel from Bass River going west to the pond. South Shore Drive crosses the channel at the outlet of the pond. Run Pond Road does not cross the western arm of the wetland. The area around the pond is not heavily developed. The salt marsh area appears to extend from the pond north up the "Run" about 700 feet and to the west past the location of the current Run Pond Road.

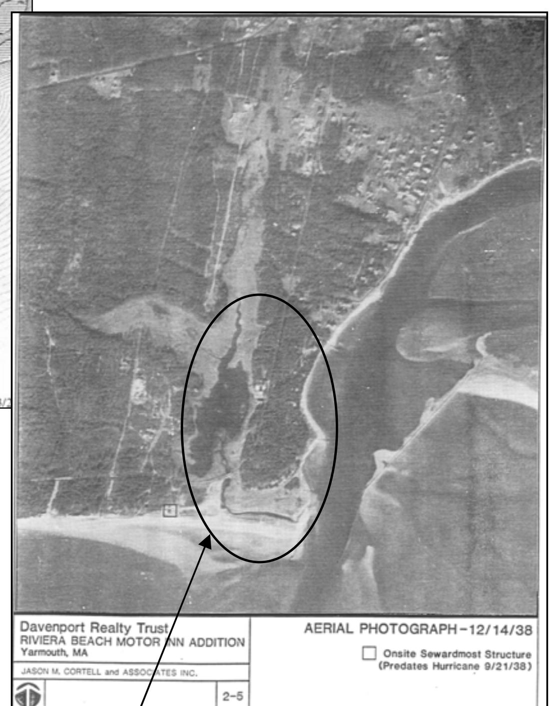
<u>September 27, 1947 aerial photograph</u>. Photograph shows an open channel similar to the 1938 photograph. The alignment of the channel is from Bass River but is further north than in the 1938 photograph. The 1947 alignment is very similar to the existing culvert alignment. Run Pond Road is present and partially intersects the west arm of the wetland. Development is present along the northwest side of the wetland.

<u>September 12, 1977 aerial photograph</u>. The open channel is no longer visible and the existing parking lot and boat ramp are present. Run Pond Road crosses the western arm of the wetland. The area around the pond is heavily developed.

<u>2001 to present</u>. Currently the area surrounding Run Pond is heavily developed with single family residences. Approximately 60 homes, most on small lots, are adjacent to Run Pond. Hundreds more homes are within the pond's watershed. Many of these homes are rented during the summer vacation season. Premier year-round resorts, hotels, and condominiums are located along the ocean front road. The area depends on on-site



Run Pond, Yarmouth
USGS, Historic Map Dated 1893



Run Pond, Yarmouth
1938 Aerial Photograph

Figure 2

septic systems for residential/commercial wastewater disposal. Town water is provided to the area.

2.2 Hydrology and Flooding

Run Pond and associated wetlands have a surface area of about 30 acres. Approximately 10 acres is open water. The remaining area is vegetated with emergent and scrub-shrub wetlands. Maximum depth in open water areas is about 3 to 4 feet. Almost all the open water area remains flooded throughout the tidal cycle.

Tidal inflow to the site is through a 900 ft. long culvert under the Town of Yarmouth's Bass River parking area. Tidal measurements made at the site indicate that there is a significant reduction in tide fluctuation compared to the tidal regime that exists in Nantucket Sound. The non-storm tide range in the Sound is about four feet while the elevations within the pond remained nearly constant. (See Appendix A, Hydrologic and Hydraulic Analysis for detailed information.)

The Run Pond salt marsh watershed has a drainage area of approximately 174 acres. The primary stream for the marsh is an unnamed brook, which originates at Willow Street in Yarmouth. The brook flows in a southerly direction, through a small-vegetated channel. The salt marsh/pond complex is bounded by Willow Street on the north, South Street on the east, South Shore Drive on the south, and Run Pond Road on the west. Overland stormwater flows into wetland depend on the size of the storm and range from about 15 cfs for a two-year storm to about 60 cfs for the 100-year event. (See Appendix A for details). In general, during dry weather no freshwater flow was observed entering the north end of the wetland.

Groundwater was not monitored for this study. However, due to the sandy substrate in the area and the topography, it is likely that the pond does receive inflow from ground water. Surface waters from the pond may also discharge through subsurface flow to Nantucket Sound and the Bass River.

The area is located in the 100-year floodplain for Nantucket Sound. The 100-year flood elevations for this area are estimated at about 10.0 feet NGVD. The 50 year, 10 year, and 1-year events are estimated at 8.4, 5.4, and 3.8 ft. NGVD, respectively. First floor elevations of nine residences close to Run Pond were surveyed and found to range from 4.7 ft. NGVD to 11.3 ft. NGVD. Due to the presence of low-lying properties near the pond, increasing the inlet size has the potential to increase property flooding during storm tides. Tide gates should be included in alternative designs to prevent any increased flooding.

2.3 Water Quality

Nutrients. The observed nutrient levels at the site were high. In order to avoid growth of nuisance vegetation, such as algae, it is recommended that total phosphorous concentrations be less than 0.10 ug/l for marine or estuarine water. (U.S. Environmental Protection Agency (EPA), Water Quality Criteria for Water 1986.) Total phosphorus levels exceeded the preliminary EPA criterion for streams in the Eastern Coastal Plain (EPA, 2002) at all stations. Nitrogen levels at several stations also exceeded preliminary EPA criterion for total nitrogen.

The source of nutrients to Run Pond is not known. However, the homes surrounding the pond utilize on-site subsurface wastewater disposal (septic systems). Given the sandy, highly permeable soils in the area, these systems are a likely source of nutrients in the pond. Other possible sources include non-point source run-off and release of nutrients from pond sediments.

Table 1. Run Pond, Nutrients

Location	Total - P, ug/l		Total- N, mg/l	
	18 July 2001	*8 August 2001*	*18 July 2001*	*8 August 2001*
S-1 Outlet at Bass River	0.38	0.44	0.24	0.48
S-2 Culvert pond side	0.55	0.37	0.52	0.54
S-3 Middle of pond	0.31	0.42	0.54	0.64
S-4 West branch	0.20	NS	1.00	NS
S-5 North end of pond, east side	0.98	0.77	0.75	0.80
Preliminary Criterion for Coastal Streams (USEPA, 2002)	0.031		0.71	

Dissolved Oxygen. Sufficient dissolved oxygen (DO) (above about 6 mg/liter) is required in a marine aquatic system in order to support fish and shellfish habitat. (Massachusetts Water Quality Standards). Values observed at Run Pond during the summer of 2001 were below this standard (See Appendix A). During the day the DO values were above the 6 mg/liter criteria due to photosynthesis by the abundant algal mats. However, during early morning hours before photosynthesis starts, DO values ranged well below 6 mg/l, with a minimum observed value of 3.24 mg/l. This indicates that there is a high oxygen demand in the pond and is likely due to oxidation processes occurring in the sediments, respiration of biota associated with the algal mats, or both.

Salinity. Salinity measurements made at the site in 2001 are provided in Appendix A. Salinity measurements in the Bass River were about 27 parts per thousand (ppt). Measurements in the pond ranged from 6 to 29 ppt. These measurements and the presence of salt marsh grasses surrounding the pond indicate that salinity conditions are suitable to support salt marsh grasses and aquatic life adapted to estuarine habitat such as soft-shell clam and common mummichog.

Observed salinity conditions change as one moves north from the pond up the "Run". Low salinity readings were observed in this area using a hand held salinometer. Vegetation on either side of the "Run" was reflective of this lower salinity level and was dominated by brackish species including cattail and *Phragmites*. No soil water chemistry data is available, but due to lack of significant flushing salinities are probably low and sulfate levels are likely to be elevated.

Temperature. Water temperature in Run Pond during the summer exceeded 30^{o}C in August of 2001 (Appendix A). High temperatures occur because the pond is shallow (high surface to volume ratio) and there is little interchange with cooler ocean waters.

2.4 Sediment Quality

Sediment core samples were collected at three sites in Run Pond. Two were taken in the channel leading to the outlet culvert (S-1 and S-2) and one was taken in the pond (S-3). The approximate locations of the cores are shown in Figure 3.

Sample	Core Recovery Depth (ft.)	Core Penetration Depth (ft.)	Collection Date
S-1	5.4	6.0	01/22/02
S-2	4.0	5.0	01/22/02
S-3	3.5	5.3	01/22/02

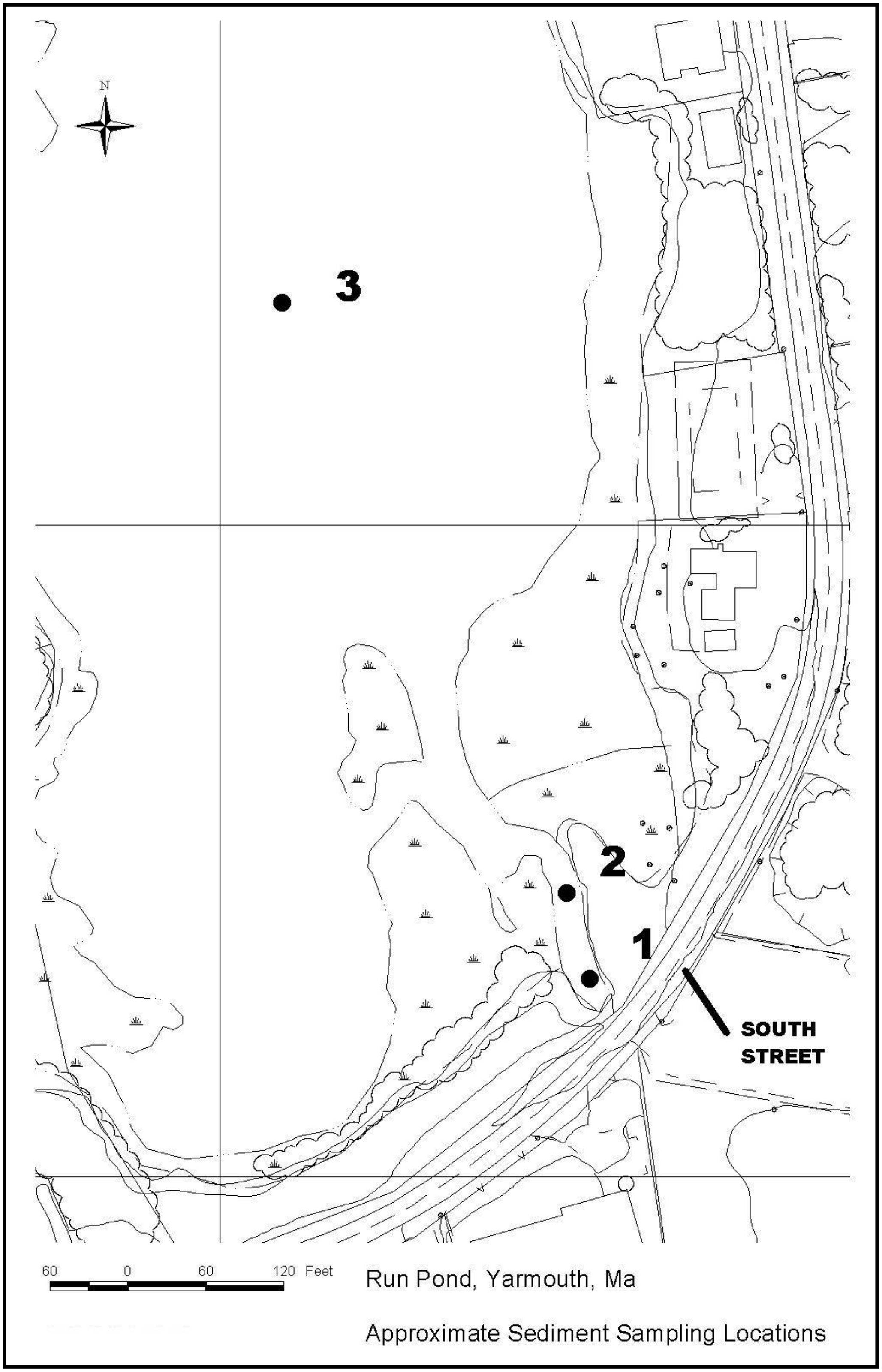

N
3
2
1
SOUTH
STREET
60 0 60 120 Feet
Run Pond, Yarmouth, Ma
Approximate Sediment Sampling Locations

Figure 3

Cores were composited for physical and chemical analyses. Analyses included metals, PCB/pesticide analyses, volatile and semi-volatile organic analyses, extractable petroleum hydrocarbons (EPH) analyses, total sulfides, total Kjeldahl nitrogen (TKN), total phosphorus (TP), grain size, total organic carbon, and total solids and total volatile solids. Detailed laboratory results and quality control reporting are contained in a separate data report entitled "Final (Sediment) Data Report, Run Pond, Massachusetts", dated March 2002 and prepared by Battelle Ocean Sciences, Inc. Data are summarized in Tables 2, 3 and 4. Sediment core logs and grain size analysis data are included in the referenced data report.

The existing sediment type in Run Pond is primarily sand. At the location of the outlet the bottom is coarse and medium sand but quickly changes to finer sand and silty material. The total organic content in the sediments at Run Pond is low with detected values at the three sites ranging from 0.09 to 3.1 percent. Water content of the sediments was observed to range from 17 percent to 81 percent.

Table 2. Run Pond, Physical Sediment Data

	S-1	S-2	S-3
Total Organic Carbon, %	0.09	1.78	3.10
Total Solids, %	85.6	55.3	56.3
Total Volatile Solids, %	0.3	4.7	6.8
Water Content, %	17	81	78
Particle Size Distribution %			
Gravel	3.52	0.00	0.00
Coarse sand	2.40	0.61	0.21
Medium sand	51.81	15.88	35.82
Fine sand	41.76	60.13	45.86
Silt	.12	12.13	10.87
Clay	.40	11.25	7.25
Unified soil classification system (USCS)	(SP) Poorly graded sands	(SC-SM) clayey sand and silty sand	(SC-SM) clayey sand and silty sand

Table 3. Run Pond, Sediment Cores, Chemical Results

Analytes	Units	S-1	S-2	S-3	PEC*	MADEP**	
						RCS-1	MACL
Arsenic	MG/KG	0.65	1.6	1.7	33	20	40
Cadmium	MG/KG	0.014	0.085	.016	4.98	2	80
Chromium	MG/KG	2.2	7.1	3.9	111	30	1000
Copper	MG/KG	1.6	6.3	1.4	149	1000	
Lead	MG/KG	4.5	18.7	2.6	128	300	2000
Mercury	MG/KG	.013	0.037	0.014	1.06	20	10
Nickel	MG/KG	1.2	4	2.7	48.6	20	0
Zinc	MG/KG	6.7	28	5.9	459	2500	
Total PAHs	MG/KG				22.8		1000
Total PCBs	UG/KG	n.d.	35	n.d.	676	2000	2000
DDE	UG/KG	n.d.	13	n.d.	31.3	3000	
DDD	UG/KG	n.d.	23	n.d.	28	4000	
Total Kjeldahl N	MG/KG	120	1300	1100			
Total Phosphorus	MG/KG	30	95	120			
Total Sulfides	MG/KG	Not detected	12	9.8			

* Probable effect concentration (McDonald, et. al. 2000)
** Chemical test results were compared with criteria in the following documents to determine suitability of the material for reuse and/or disposal requirements: (1) the Massachusetts Contingency Plan Reportable Concentration for the Soil 1 Category (MCP RCS-1, the most strict category for upland soils); (2) Maximum Allowable Contaminant Levels (MACLs) (Table 1 in MA DEP Interim Policy #COMM-94-007, *Sampling, Analysis, Handling and Tracking requirements Dredged Sediment Reused or Disposed at Massachusetts Permitted Landfills*) used to identify whether sediments can be reused at lined landfills.

Metal levels in pond sediments were low and unlikely to pose a risk to ecological receptors or human health. Concentrations of all metals were well below Probable Effect Concentrations (PECs), indicating a low probability of toxicity to benthic invertebrates.

Results for volatile and semi-volatile analyses are included in the separate data report entitled "Final (Sediment) Data Report, Run Pond, Massachusetts", dated March 2002. All three samples had detected levels of acetone and methylene chloride, however, detected amounts are likely the result of laboratory contaminants. Semi-volatile organics (PAHs) were detected in S1 and S2. PAH levels were well below the PEC and Massachusetts standards. Low concentrations of extractable petroleum hydrocarbons (EPH) were also detected in the three samples.

Sediments were tested for both Aroclors and PCB congeners. Aroclors were not detected in any of the composited samples. PCB congners were detected in one sample S-2. These levels were: 2,3',4,4',5- pentaCb (0.0012 mg/kg). 2,2',3,4,4',5'-hexaCB (0.0012 mg/kg). And 2,2',4,4'5,5'- hexaCB (0.0011 mg/kg). Observed values are below 2 mg/kg) so the material is suitable for unconfined disposal and does not pose a risk to human or ecological receptors.

Pesticides were not detected in S1 or S 3 sediment samples. Sample S2 has small amounts of 4,4' DDE (13 ug/kg or ppb) and 4,4'- DDD (23ug/kg or ppb). DDD was released to the environment through its use as an insecticide and is also a biodegradation product of DDT. Its use in the United States has been banned since the early 1970's. The levels observed in S2 are not unusual for sediments impacted by human activities.

Concentrations of nutrients in Run Pond sediment (TKN and total phosphorus) are in the range normally found in pond sediments in the northeast (Telecom, NRCS 9/2003). Nutrients are a concern in pond sediment as they may be released to overlying waters and cause growth of nuisance aquatic vegetation.

Total sulfides represent the amount of all sulfide compounds in a sample. Sulfides are formed by the anaerobic breakdown of organic matter. The biological effects of sulfide in sediments are poorly understood, yet can be important in determining sediment toxicity to a wide range of organisms and are normally found in aquatic sediments. Sulfides were detected in Run Pond and this was as expected. Run Pond sediments were sampled in the winter and higher sulfide concentration may occur during summer months when sediment oxygen demand is high and sulfates are rapidly reduced to sulfides. High sulfide levels can be toxic to benthic organisms and vegetation, and cause odor problems.

Table 4. Run Pond, EPH Results

Analytes	Units	S1	S2	S3	MA Background Soil Concentration or RCS-1 Standards from 310 CMR 40.1600
C9-C18 Aliphatic	mg/kg dry wt.	U*	6.9	7.0	1000
C19-C36 Aliphatic	mg/kg dry wt.	U	U	U	25000
C11-C22 Aliphatic	mg/kg dry wt.	U	4.4	1.9	200

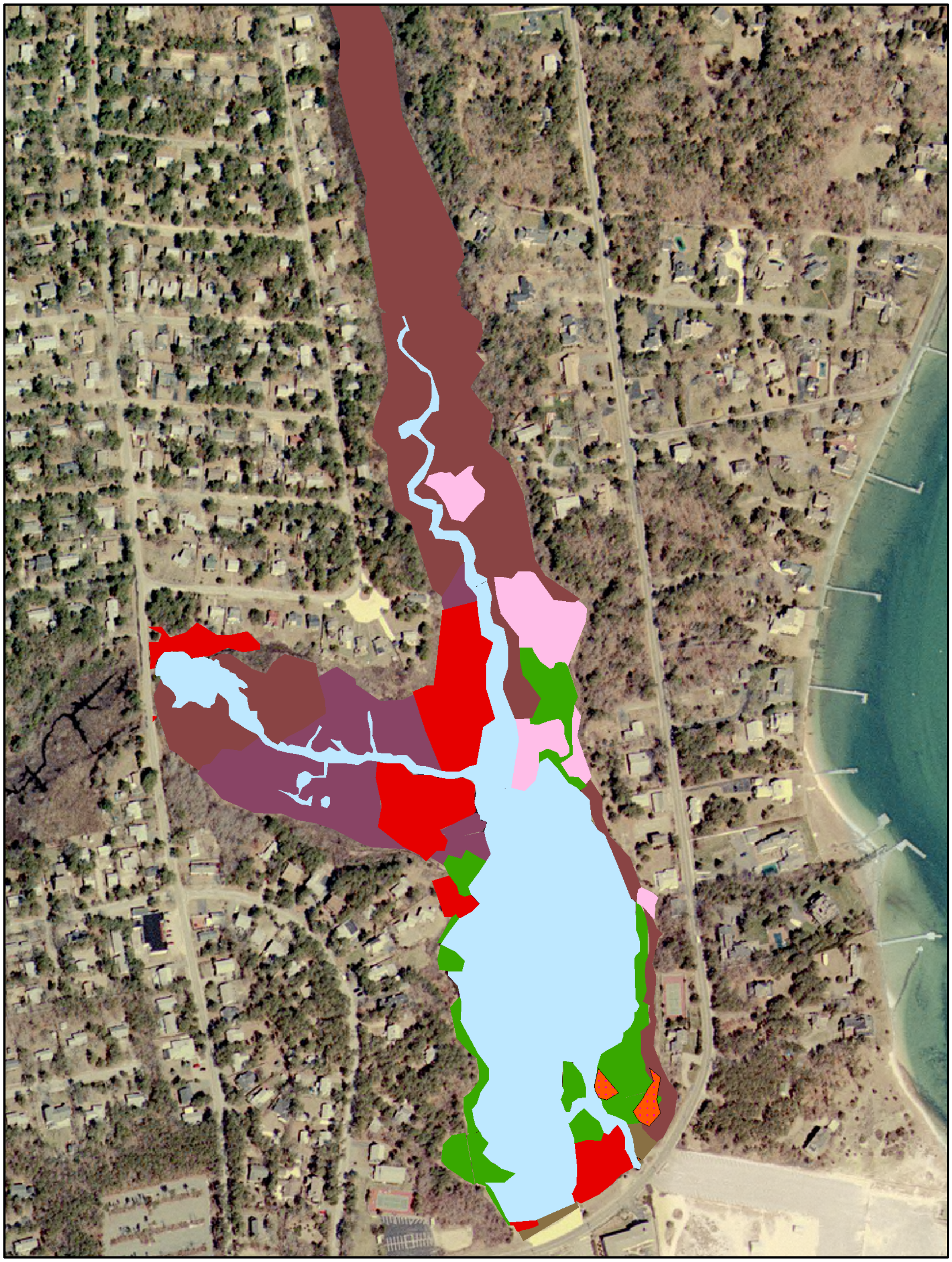
*U - not detected

2.5 Biological Resources

<u>Wetlands and Wetland Plant Communities</u>

Historic aerials for the site were reviewed to document previous site conditions and any apparent trends in wetland vegetation at the site over time. A December 14, 1938 aerial photograph shows an open channel from Bass River going west to the pond. Salt marsh vegetation appears to extend from the pond north up the "Run" about 700 feet and to the west, past the location of the current Run Pond Road. A September 27, 1947 aerial photograph shows an open channel similar to the 1938 photograph. The quality of photograph copy does not allow for interpretation of marsh vegetation. Town officials indicate the open channel was replaced with the existing culvert in about 1950. A September 12, 1977 aerial photograph shows some of the salt marsh along the Run and near Run Pond Road was apparently replaced with brackish vegetation.

Existing wetland community types were mapped during the spring of 2004 and fall of 2007 using 2001 color aerial imagery and GPS assisted field surveys. Results are presented in Figure 4 and tabulated in Table 5. Plant species observed at Run Pond are listed in Table 6. The 30.5 acre pond wetland complex consists of 10.6 acre of open water habitat, 9.9 acres of scrub-shrub wetland, and 9.8 acre of emergent wetland, and in addition there are 0.2 acres of disturbed area.



0 250 500 1,000 1,500 Feet

Legend

- Phragmites
- Typha
- Typha/Lythrum mix
- disturbed area
- open water
- salt marsh
- shrub
- low density Phragmites

Run Pond
Yarmouth, Mass

µ

Vegetation Type
Current Conditions

Figure 4

Table 5. Habitat Type, Run Pond

Habitat Type	Acres
Emergent Wetland	
Salt marsh grasses and herbs	*2.3*
Typha	*3.1*
Typha/Lythrum mix	*1.6*
Phragmites	*2.8*
Emergent Wetland - total	9.8
Scrub-shrub	9.9
Open water	10.6
Disturbed area	0.2
TOTAL	30.5

Vegetation occurring in each of these community types is described below.

Open Water. Run Pond develops extensive mats of filamentous algae during the summer months. In 2001 the mats were formed primarily by (*Chaetomorpha*) a green alga. The cause of these algae blooms is probably a combination of nutrient loading and reduced tidal flushing of the pond. Karl von Hone, Director, Yarmouth Department of Natural Resources indicates that algal mat cover is typically about 50% and that the blooms are becoming more severe. Submerged aquatic vegetation is very sparse. In 2001, only a few stands of eelgrass (*Zostera marina*) were noted growing among the dense algal mats.

Emergent. Four main emergent cover types occur in Run Pond; salt marsh dominated by Spartina and other salt tolerant grasses, cattail (*Typha* sp.), cattail/purple loosestrife, and reed (*Phragmites australis*).

Salt marsh is most prevalent along the Run Pond shoreline near the outlet where higher salinity limits the growth of freshwater emergents such as cattail and purple loosestrife. *Spartina patens* and to a lesser extent *Spartina alternifolia* are the dominant saltmarsh grasses. Associated species include black grass, saltmarsh bulrush, wax myrtle, bayberry, and saltmarsh fleabane.

Brackish water emergent wetland dominated by cattail (*cf Typha glauca*) occurs along the western channel. Associated species include purple loosestrife and poison ivy.

Sphagnum moss and fruticose lichens occur in some areas. Cattail/purple loosestrife marsh occurs along the eastern side of the north channel.

Six distinct stands of *Phragmites*, totaling 2.8 acres, occur at Run Pond. The largest two stands are located at the confluence of the western and northern channels with Run Pond. These stands are gradually expanding into adjacent wetland communities (see Photograph 2). Scattered *Phragmites* also occurs in scrub-shrub wetland and saltmarsh along the southeast shoreline of the pond. Many Atlantic coast marshes have been invaded by *Phragmites* since European settlement. The proliferation of *Phragmites* has been facilitated by alteration of tidal regimes, filling of wetlands, nitrogen eutrophication, and the ascendancy of an invasive variety native to Eurasia (Chambers et al., 1999; Bertness et al., 2002, Saltenstall, 2003). *Phragmites* occurring at Run Pond is the invasive variety.

<u>Scrub-Shrub</u>. Scrub-shrub wetland occurs at the upper reaches of the western and northern channels and in a narrow band along Run Pond between the emergent zone and upland vegetation. Species noted include sweet gale, alder, poison ivy, gray birch, bayberry, red maple, pin oak, wax myrtle, chokecherry, winterberry holly, northern arrowwood, green briar, narrow leaved goldenrod, and marsh fern.

<u>Ditches and Pools</u>. The 2001 aerial photographs show numerous drainage ditches, probably dug to control mosquitoes. The ditches range from about 2 ft to 6 feet wide. There are also several pools within emergent and scrub-shrub wetland located along the western channel.

<u>Disturbed Areas</u>. Upland near the Run Pond outlet is vegetated by a variety of weedy species. Species noted include spotted knotweed, beach rose, cedar, common milkweed, oriental bittersweet, horseweed,, ragweed, rabbit foot clover, red clover, common St. Johnswort, and common plantain.

Table 6. Vegetation List, Run Pond, Yarmouth, MA

	Scientific Name	Common Name
Trees	*Acer rubrum*	Red maple
	Alnus incana rugosa	Speckled alder
	Betula populifolia	Gray birch
	Juniperus virginiana	Red cedar
	Populus tremuloides	Aspen
	Prunus sp.	Cherry
	Quercus bicolor	Swamp white oak
	Pinus rigida	Pitch pine
Shrubs and Vines	*Alnus incana rugosa*	Speckled alder
	Cornus sp.	Dogwood
	Cornus stolonifera	Red-osier dogwood
	Myrica cerifera	Wax myrtle
	Myrica gale	Sweet gale
	Myrica pensylvanica	Bayberry
	Parthenocissus quinquefolia	Virginia creeper
	Prunus sp.	Cherry
	Rhus radicans	Poison ivy
	Rosa rugosa	Rugosa rose
	Rubus sp.	Bramble
	Salix spp.	Willow sp.
	Smilax rotundifolia	Common greenbriar
	Spirea latiolia	Meadowsweet
	Toxicodendron radicans	Poison ivy
Herbaceous Plants	*Althaea officinalis*	Marsh mallow
	Carex sp	Sedge
	Graminae	Unidentifeid grass
	Juncus sp.	Unknown rush
	Lythrum salicaria	Purple loosestrife
	Phragmites australis	Common reed
	Polygonum cuspidatum	Oriental knotweed
	Scirpus pungens	Three-squared bullrush
	Spartina alterniflora	Smooth cordgrass
	Spartina patens	Salt meadow grass
	Typha glauca	Cattail
	Zostera marina	Eelgrass
Lower Plants	*Chaetomorpha sp.*	Filamentous green algae
	Lichen sp.	Fructicose lichen
	Sphagnum sp.	Sphagnum moss

Aquatic Invertebrates

The Corps collected twelve grab samples along the length of Run Pond to assess the pre-restoration condition of benthic invertebrate communities. Sample stations started in the stream bed at the culvert (Station A) and extended through the pond and upstream into the north channel, the "Run" (Station N). The samples were transported to the University of Rhode Island for sieving, and identification and enumeration of organisms.

Numbers of species and individuals per sample are provided in Appendix B. No benthic invertebrates were found in samples C, G, N and only one individual was found in sample I. Samples A and B contained numbers of species and individuals typical of coastal ponds in this region. The species found in samples A and B are characteristic of estuarine habitats with a degree of stress, but contained an abundance of detrital food.

The remaining samples contained low numbers of species (2-5) consistent with stressed environments. Samples in the mid portion of the pond had generally low numbers of individuals. At the head of the pond (samples J, L, M) along the "Run" numbers of individuals were increased by the presence of species adapted to freshwater or near-freshwater conditions (chironomids, oligochaetes, the amphipod, *M. mucronatus*). Some of the species present are indicators of pollution (*Capitella capitata, Hypereteone heteropoda, Neanthes succinea, Polydora cornuta*) however it is easy to explain their presence in this location to a physically stressful environment and an abundance of detrital food. Soft-shell clam spat were found only in Sample A.

Quahog (*Mercenaria mercenaria*) were abundant in and near the Run Pond outlet channel in August of 2001. Adult soft-shell clam, green crabs (*Carcinus maenas*), and tub dwelling annelids were also observed in this area. Blue crabs (*Callinectes sapidus*) are abundant in the pond and in the Bass River estuary (personnel communication, Karl von Hone, Director, Yarmouth Department of Natural Resources 2003).

Numerous adults of the seaside dragonlet (*Erythroxiplax berenice*) were seen at Run Pond in August of 2004. The dragonlet is one of the few dragonflies to occur in salt-water habitat in Massachusetts. Females reportedly oviposit on algal mats (Nikula et. al. 2003).

Fish

No formal fisheries surveys have been conducted for Run Pond. Fish observed in the pond include common mumichog (*Fundulus heteroclitus)*, sticklebacks, and American eel (elveers) (von Hone, personal communication, 2003). Other estuarine fish may occasionally access the pond through the existing 36" culvert during incoming tides. Lack of adequate fish passage and periodic low dissolved oxygen levels caused by decomposing algal mats probably limits development of the resident fish community.

Historically, Run Pond is reported to have provided river herring access to Long Pond. This connection was lost due to construction of a shopping plaza in the 1940's or early 1950's and cannot be restored. The existing Run Pond system does not now have sufficient freshwater spawning habitat to support river herring or other anadromous fish such as alewife or smelt.

Designated Essential Fish Habitat (EFH) for the coastal area near Run Pond and Bass River area are listed in Table 7. It is unlikely due to the small culvert and poor water quality that any designate life stages of the species listed utilize the pond directly, however detritus and other biological resources exported from the pond during the tidal cycle may provide a food source for some of the EFH listed species or their prey.

Essential Fish Habitat (EFH) Designation Yarmouth, MA 10' x 10' Square Coordinates:				
Boundary	North	East	South	West
Coordinate	41° 40.0'N	70° 10.0'W	41° 30.0'N	70° 20.0'W

Square Description (i.e. habitat, landmarks, coastline markers): Atlantic Ocean waters within the square affecting the following: south of from West Dennis, MA., past Yarmouth, MA., Hyannis, MA., and part of Barnstable, MA., to Craigsville, MA., within Nantucket Sound.

Table 7. Essential Fish Habitat (EFH) Designation Yarmouth, MA

Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod *(Gadus morhua)*				X
winter flounder *(Pleuronectes americanus)*	X	X	X	X
windowpane flounder *(Scopthalmus aquosus)*				X
long finned squid *(Loligo pealei)*	n/a	n/a	X	X
short finned squid *(Illex illecebrosus)*	n/a	n/a		
Atlantic butterfish (Peprilus triacanthus)	X	X	X	X
Atlantic mackerel (Scomber scombrus)	X	X	X	X
summer flounder (Paralicthys dentatus)	X	X	X	X
scup (Stenotomus chrysops)	n/a	n/a	X	X
black sea bass (Centropristus striata)	n/a	X	X	X
surf clam (Spisula solidissima)	n/a	n/a	X	X
king mackerel (Scomberomorus cavalla)	X	X	X	X
Spanish mackerel (Scomberomorus maculatus)	X	X	X	X
Cobia (Rachycentron canadum)	X	X	X	X

Wildlife

Run Pond provides habitat for many bird species characteristic of coastal Massachusetts wetlands. Shallow open water habitat provides excellent foraging habitat for wading birds such as great blue heron. Waterfowl such as Canada goose, mallard, and black duck may nest and/or over winter in the pond. Other waterfowl use the pond as a resting area during spring and fall migrations. Emergent wetland provides nesting and foraging habitat for songbirds such as red wing blackbird and marsh wren. Other songbirds, such as yellow warbler utilize scrub-shrub wetlands. Tree swallow forage on midges, mosquitoes, and other insects produced by the pond. Raptors such as red tailed hawk forage for meadow vole in the emergent meadows. Run Pond, however, provides less than optimal habitat for some species. The pond currently has little intertidal habitat, limiting its value for resident and migratory shorebirds such as sandpipers and yellowlegs, which forage on mudflats. Floating algal mats, however, provide foraging habitat for shorebirds during the summer. One day in early August of 2004 more than 100 shorebirds (mostly semipalmated plovers) were observed foraging on the mats. The pond also has only a few acres of salt marsh, so has minimal value for salt marsh specialists such as willet, salt marsh sparrow, and seaside sparrow.

Mammals likely to occur in the project area include meadow vole, muskrat, Virginia opossum, striped skunk, raccoon, red fox, meadow vole, red fox, and coyote. Reptiles and amphibians likely to occur at the site include garter snake, painted turtle and snapping turtle.

Threatened and Endangered Species

US Fish and Wildlife Service, National Marine Fisheries Service, and Massachusetts Division of Fisheries and Wildlife were contacted to determine the presence of any rare or endangered species or species of special concern. Agencies indicated that no state or Federal-listed or proposed, threatened or endangered species are known to occur in the project area, with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Copies of coordination letters are included in Attachment 1.

2.6 Historic and Archaeological Resources

Yarmouth is a residential and resort community and a commercial center located on the central Cape Cod peninsula between Lewis Bay and Bass River on Nantucket

Sound and Mill Creek and Chase Garden Creek on Cape Cod Bay. Established as a frontier town of Plymouth Bay Colony, Yarmouth was originally composed of portions of Chatham, Harwich, Brewster, Dennis, and the Barnstable village of Cummaquid.

Native American tribes under the Wampanoag Nation lived in the area that is now Yarmouth and Dennis. The Pawkannawkut Indians, who lived near Bass River in South Yarmouth, referred to the south side of Yarmouth as “Mattacheese” meaning “planting lands by the sea”. Indians held the land until smallpox epidemics wiped out most of the population. Many coastal, riverine, and pond-side Native site concentrations are likely, particularly in the northwestern “Mattacheese” and southeastern Bass River areas. The first permanent colonial settlement in Yarmouth occurred around 1639 in the northwest portion of town, with the construction of the first meetinghouse west of White’s Brook. By 1640, “Mattacheese” was renamed Yarmouth after a seaside town in England.

The early settlers were farmers and agriculture was the primary means of subsistence for the community. However, Cape Cod Bay, Nantucket Sound, and nearby coves provided lobster, mackerel, and cod as well as scallops, quahogs, clams, and oysters. Geese and ducks were hunted in the salt marshes and game was plentiful in the dense forests. Dispersed 17th and 18th Century colonial agricultural settlement concentrated on the north side, with a Native focus in the Bass River area in the southeast through the late 18th Century. Late 18th and early 19th Century prosperity from fishing, salt-making, and shipping stimulated village development at Bass River and South Yarmouth.

In the early 19th Century, Yarmouthport and Yarmouth Village developed as prosperous bayside commercial centers. Completion of the Cape Cod railroad to its eastern terminus at Yarmouthport during 1854-63 further stimulated local development. Decline of the regional maritime economy in the late 19th Century resulted in significant local population loss with little new development, except for resort-oriented growth at the Yarmouth Camp Meeting Grounds (1863) along the rail corridor at the western border, along Lewis Bay east of Hyannis and at Bass River. South shore resort development intensified with the rise of the automobile and the establishment of Route 28 as a regional highway corridor. Intensive commercial development along Route 28 has occurred as well as residential development along Lewis Bay, Parker’s Neck, and Bass River and north of Route 28. Commercial development along Route 28 in the southwest and south central areas has left only fragmentary remains of the pre-1940 historic landscape, although a significant village cluster remains along the Main Street corridor at Bass River and South Yarmouth in the southeast.

A review of archaeological site files at the Massachusetts Historical Commission indicated that several pre-contact sites are located to the north of the project area adjacent to several small ponds. These sites were collected under the auspices of the Massachusetts Archaeological Society and artifact collections are in private hands. An additional pre-contact site has been recorded for Davis Beach (West Dennis Beach) in Dennis on the opposite side of the Bass River from Run Pond. Also surface collected on the beach, but with some material coming from dredging piles, this site contains a variety of projectile points and stone tools and has been dated from the Middle Archaic Period (7500-5000 years Before Present (BP)) through the Late Woodland Period (1000-450 BP). There are no known or recorded sites within the proposed project area.

2.7 Socio-Economic Resources

The Town of Yarmouth, located on Cape Cod, was incorporated in 1639 and for many years was a rural community comprised of farmers and fishermen. Comprised of three villages; South Yarmouth, West Yarmouth, and Yarmouth Port, the Town became a popular vacation destination at the turn of the twentieth century and has experienced significant dense commercial and residential development from about 1940 to present. The town is governed by a Board of Selectmen with an Open Town Meeting.

<u>Geography</u>. The Town of Yarmouth is approximately 28.2 square miles in total area and 24.25 in land area. The town has approximately 7 miles of shoreline on Nantucket Sound and Cape Cod Bay, 30 ponds, and 15 saltwater beaches and five freshwater beaches.

<u>Population</u>. Yarmouth's year-round population in year 2000 was approximately 24,800 (873 per sq. mile). During the summer, this figure more than doubles. In the 2000 Census, 96.2 % of the population identified themselves as white (higher than the state average). Median age is 48.7 (higher than the state average).

<u>Income and Housing:</u> Median household income in 2000 was $39,808. Median house value was $151,200. Both values are higher than the state average. Approximately 76 % of housing units are owner occupied.

Employment: Total employment in 2001 was 8,887. Approximately 78% of people were employed in the services or retail trade sectors, 12 % by government, 6 % by construction, 2% by manufacturing, and 2 % by agriculture or fishing.

Recreational Resources. Yarmouth has several beaches that are open to the public. One of the largest town beaches, the Bass River Beach, is located on Nantucket Sound south of Run Pond. A parking area between the beach and Run Pond provides public parking (for a fee) and access to the beach, a picnic area, volleyball courts, a boat ramp, and a fishing pier. The parking area has space for 190 cars and is generally full to capacity weekends during the summer. Estimated annual usership of the Bass River Beach supported by the parking area is 45,828 user days. Recreational use of Run Pond is light. The pond's shallow depth limits boating to the occasional canoe or kayak. There are no public beaches or boat ramps on the pond. The pond is not used for recreational fishing. There is a minor recreational blue crab fishery in Run Pond and a much more active crab fishery in the Bass River. According to Karl von Hon (Yarmouth Natural Resources Department), a handful of people fish for crabs in Run Pond near its outlet. The blue crab season runs from June to October.

Commercial Fisheries. The pond does not support commercial finfish or shellfish fisheries.

Environmental Justice. Portions of Yarmouth, including the area around Run pond are mapped as Environmental Justice (EJ) Communities by the Massachusetts Executive Office of Energy and Environmental Affairs (see: http://maps.massgis.state.ma.us/EJ/viewer.htm). EJ communities in Massachusetts are determined by the following criteria: 65% or less of the statewide median income; or 25% of the residents are minority; or 25% of the residents are foreign-born; or 25% of the residents are lacking English language proficiency. Yarmouth meets two EJ criteria: 65% or less of the statewide median income and 25% of the residents are foreign-born.

2.8 Air quality

The entire state of Massachusetts including Barnstable County is classified and designated as a serious non- attainment zone for ozone (O3), and is part of the Northeast Ozone Transport Region which extends northeast from Maryland and includes all the six new England states. Non-attainment zones are areas where the national Ambient Air Quality Standards (NAAQS) have not been met.

2.9 Hazardous/Radiological Waste

There are no known hazardous or radiological waste sites near Run Pond. Sediment testing conducted on sediment from the pond indicates that concentrations of contaminants in the sediment tested are low and pose no risk to human health or ecological receptors.

3.0 PROJECT FORMULATION AND SELECTION

3.1 Plan Formulation

Prior to beginning a restoration project it is important to establish the goals and objectives and identify project constraints. These statements form the basis of project design and evaluation. Goals are a general statement of the intent of the project. Objectives are more precise and define what it is you are working towards, such as the specific characteristics of water quality to be achieved or the species composition of the various communities of biota to be restored. Constraints set the boundaries within which plan formulation operates.

Goals

- Identify and recommend an effective, affordable and appropriate ecosystem restoration plan for Run Pond. The plan should be acceptable to the public, Local Sponsor, and resource and regulatory agencies.

- Restore a combination of tidal creek, salt pond, intertidal flats, and salt marsh that improves the overall fish and wildlife habitat value of Run Pond.

- Minimize adverse impacts to natural, cultural, and socioeconomic resources.

Objectives and Constraints

- Improve water quality within the pond to restore aquatic habitat and reduce nuisance algal blooms. Key concerns are low dissolved oxygen and high nutrient levels during summer months.

- Increase salinity in emergent wetlands to restore saltmarsh vegetation.

- Eradicate *Phragmites*, an invasive emergent plant that threatens to displace *Spartina*, cattail, and other emergents.

- Maintain some permanent open water during low tide to provide a refuge for estuarine fish and invertebrates.

- Avoid long-term adverse impacts to the town beach and parking area.

- Avoid increased flooding to structures near Run Pond.

- Incorporate the request of the Local Sponsor to keep any proposed solution within the land currently owned by the town.

3.2 Alternatives

Based on the investigation of existing conditions it was determined that in order to restore the fringing wetland vegetation and salt pond habitat, both an increase in high tide elevation and an increase in tidal exchange are required. A computer model of the site was developed and utilized to formulate culvert and open channel alternatives that would provide for these two improvements. See Appendix A, Hydraulics and Hydrology Analysis.

The intent was to identify culvert and/or open channel alternatives large enough to allow the water level in the marsh to equal the water level in the ocean during spring high tide and to allow for increased tidal flushing.

The following proposed solutions were formulated based on meeting this hydraulic criteria and the Local Sponsor's desire to keep any proposed solution within the land currently owned by the town and, to the extent possible, to minimize the loss of parking spaces at the town public parking area.

<u>Alternative 1 - No Action Alternative - Expected future without project conditions</u>. If no Federal action is taken, it is assumed that the site will remain degraded. Over time, conditions will likely worsen. Given restricted tidal inflow, invasive species may continue to spread and may eventually out-compete salt marsh vegetation and dominate the fringing wetland at the pond. Also, given limited tidal flushing, the water quality of the pond will continue to be poor with low dissolved oxygen and dense summer algal mats.

<u>Alternative 2 - Install new 48-inch diameter culvert</u>. (See Figure 5) This alternative involves installation of a 48-inch diameter culvert to supplement flow through the existing 36" diameter culvert. The culvert would extend from a new headwall north of South Shore Drive through the town public parking area to the outlet at Bass River. As the culvert is located beneath the surface of the existing parking lot, no parking spaces would be lost under this alternative. The culvert invert at South Shore Road would be set at El. -1.0 ft. NGVD or about 1 foot lower than the existing culvert invert.

The existing channel upstream of the headwall would be excavated to El. –1.0 NGVD and widened to a 50-foot width for a distance of 100 feet upstream of the headwall. About 700 CY of silty-sand material would be excavated from the channel area and hauled to a disposal area. The lower 315 feet of the existing culvert would be replaced with a new 36” diameter culvert parallel to the new 48” culvert to the outlet at Bass River. The invert elevations of both culverts at the outlet headwall would be set at El. – 2.39 NGVD. The alternative would also include installation of self-adjusting tide gates for each culvert to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond.

The alternative is expected to increase the spring high tide range in the wetland by about a tenth of a foot from existing conditions of 1.7 ft. NGVD to 1.8 feet NGVD. As compared to the ocean level of 2.0 feet NGVD the new 48-inch culvert will not completely eliminate the tidal restriction at the site. The 48-inch culvert will result in improved tidal exchange at the site with calculated volume exchange rates improving from an existing estimated value of 52 hours to 14 hours. The new culvert will increase the low tide range by about 1 ft. to about 0.3 ft. NGVD. This will result in portions of the pond going dry during low tide.

<u>Alternative 3- Install Two -5 ft. by 10 ft. box culverts</u>. Under this alternative (See Figure 6) two, 5’x10’ reinforced concrete box culverts would be installed from a new inlet headwall north of South Shore Drive to the outlet headwall at Bass River. As the culverts are located beneath the surface of the existing parking lot, no parking spaces would be lost under this alternative. The culvert invert upstream of South Shore Road would be similarly set at El. -1.0 ft. NGVD. The existing channel upstream of the headwall would also be excavated to El. –1.0 NGVD and widened to a 50-foot width for a distance of 100 feet upstream of the headwall. About 700 CY of material would be excavated from the channel area and hauled to a disposal area. Approximately 480 feet of the lower end of the existing culvert will be replaced with 36” diameter culvert in a separate trench parallel to the box culverts. Approximately 9600 cy of material would be excavated to install the new culvert. The invert elevations of all three culverts at the outlet would be set at El. –2.39 NGVD. The alternative would also include installation of self-adjusting tide gates for the twin box culverts to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond.

This alternative is expected to increase the spring tide water surface elevation to about 2.0 ft. NGVD. This duplicates ocean levels and should be sufficient to increase flooding and restoration of the fringing wetland around the pond. The two 5'x10' box culverts will result in improved tidal exchange at the site with calculated volume exchange rates improving from an existing estimated value of 52 hours to 11 hours. It is likely that the pond bottom will be exposed (i.e. no water) during low tide.

<u>Alternative 4. Box Culvert/Open Channel.</u> In order to obtain additional environmental benefits, several combination box culvert/open channel alternatives were considered. (See Figure 7.)

Two of the alternatives included twin, 5’x10’ concrete box culverts under the roadway and a portion of the parking area, with a 20-foot-wide open channel with 1V/2.5H side slopes, through the southern portion of the existing parking lot to the Bass River.

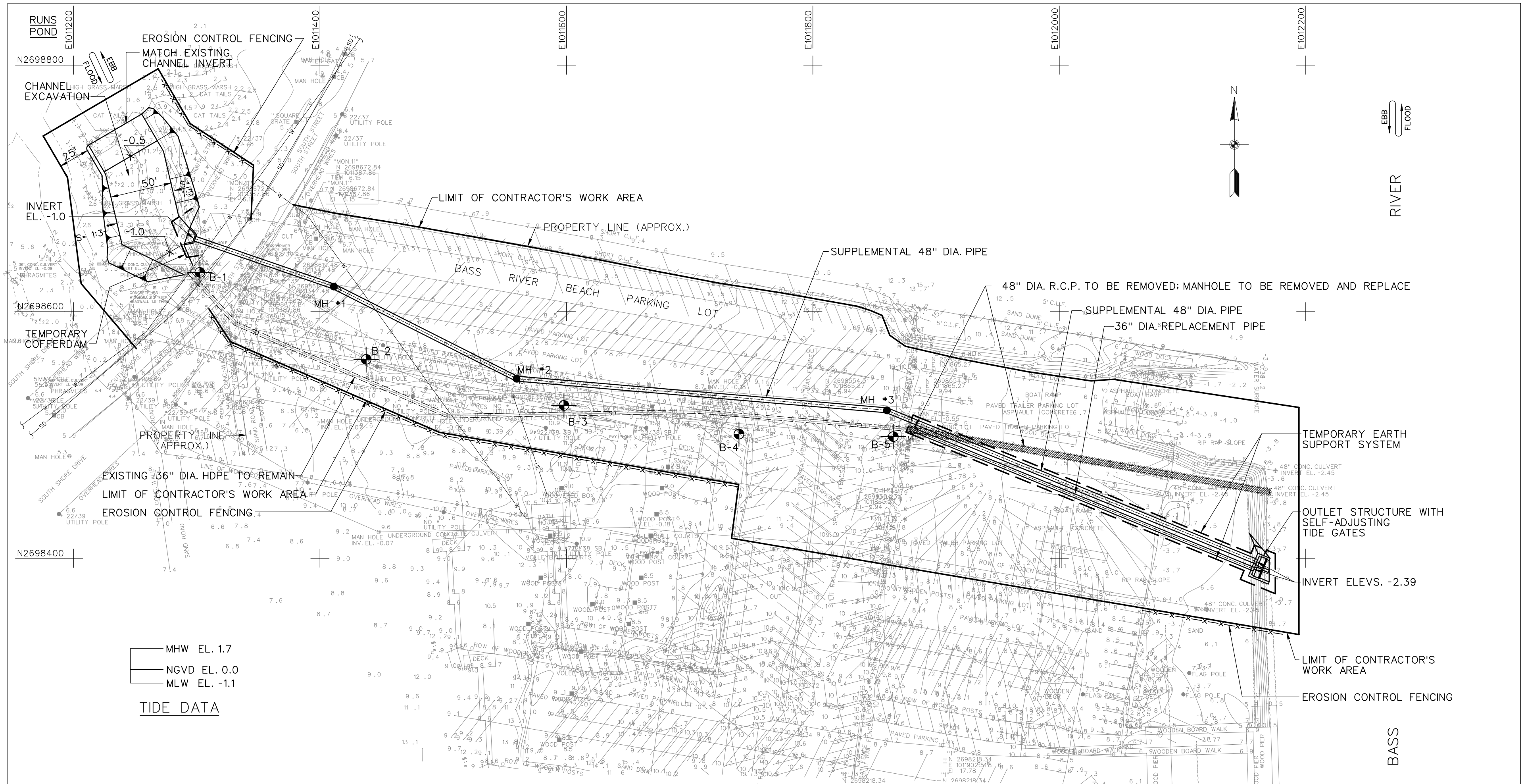
- Alignment “A” crosses the existing dune area south of the boat house and the southern portion of the parking lot, impacting 67 spaces.

- Alignment “B” crosses through the existing recreation area and septic system east of the bathhouse and the existing parking lot to Bass River just north of the existing wood pier.

- Alignment “C”, involves installation of a combination box culvert/open channel on private property north of the town parking lot and existing boat ramp. For each of these three alternatives, self-regulating tide gates would be installed on the box culvert outlet headwall at the upstream limit of the open channel.

Concept layouts of these three alignments with open channel components were presented to the Local Sponsor for discussion and selection of a preferred alignment for further development and inclusion in study design alternatives. Due to concerns with the proximity of the channel to the Bass River Beach and the potential for erosion, Alignment “A” was eliminated from consideration. Alignment “C” was eliminated as this alternative was not acceptable to the town due to prohibitive real estate costs for the parcel of required private property.

Alignment “B” was eliminated as 94 parking spaces would be lost, beach facilities would be affected, and a bridge over the channel to the southern end of the parking lot would be needed.



TIDE DATA

- MHW EL. 1.7
- NGVD EL. 0.0
- MLW EL. -1.1

NOTES:

1. COORDINATES REFER TO NORTH AMERICAN DATUM OF 1983 (N.A.D. 83).
2. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (N.G.V.D. 29), FORMERLY KNOWN AS MEAN SEA LEVEL OF 1929.
3. BORING INFORMATION OBTAINED FROM DRAWING ENTITLED "DRAINAGE IMPROVEMENTS, BASS RIVER BEACH CULVERT, SOUTH STREET, YARMOUTH, MA. PLAN AND DETAILS," PREPARED BY BRAMAN ENGINEERING COMPANY, LTD. DATED APRIL 8, 1993 FOR TOWN OF YARMOUTH ENGINEERING DEPARTMENT.

BASS RIVER BEACH
A.K.A. SMUGGLERS BEACH

PLAN
SCALE: 1" = 40'

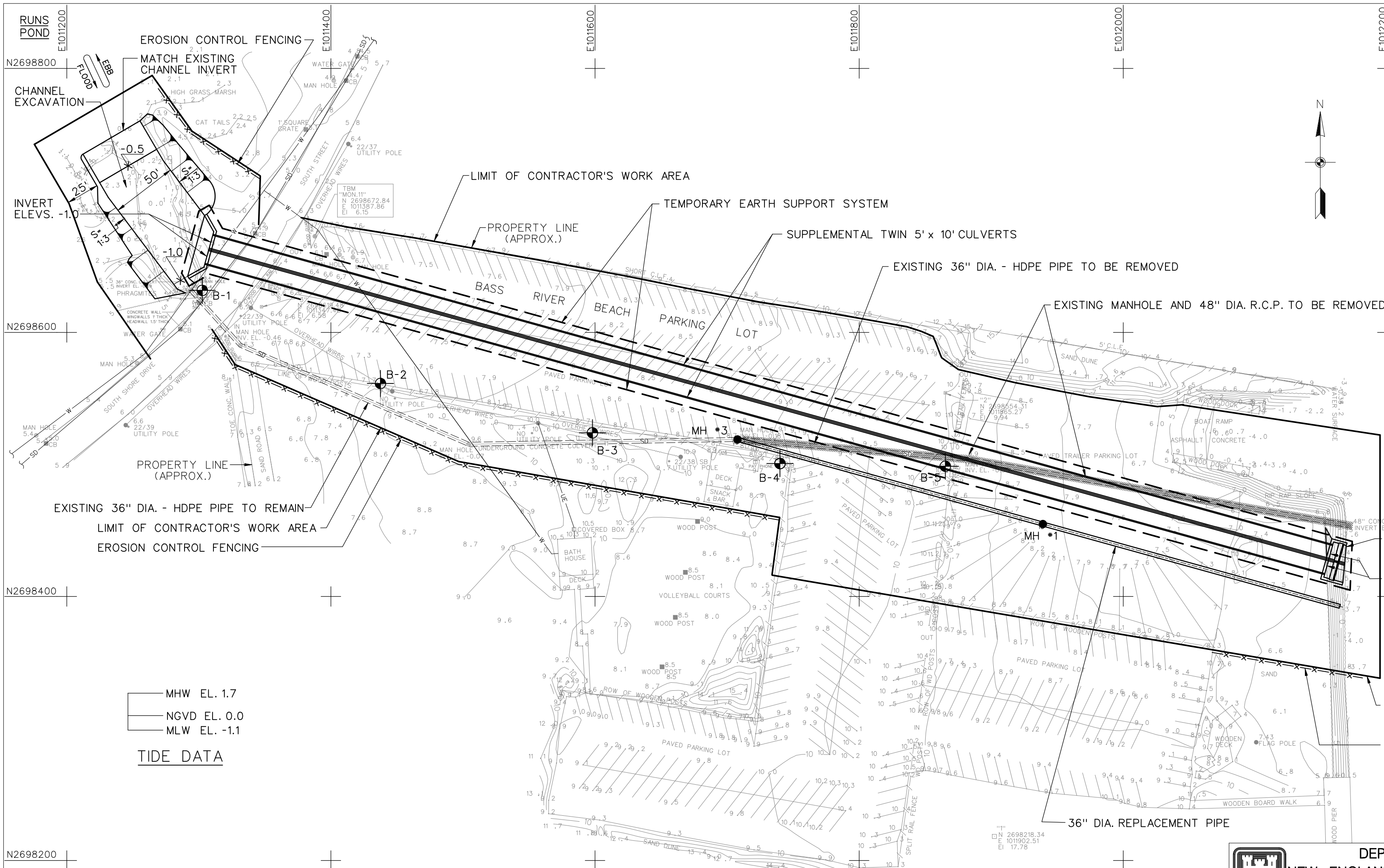
GRAPHIC SCALE
1" = 40'
40' 0 40' 80'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

AQUATIC ECOSYSTEM RESTORATION PROGRAM
RUN POND
YARMOUTH, MASSACHUSETTS

SUPPLEMENTAL 48" DIA. PIPE
GENERAL PLAN

FIGURE 5



NOTES:

1. COORDINATES REFER TO NORTH AMERICAN DATUM OF 1983 (N.A.D. 83).
2. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (N.G.V.D. 29), FORMERLY KNOWN AS MEAN SEA LEVEL OF 1929.
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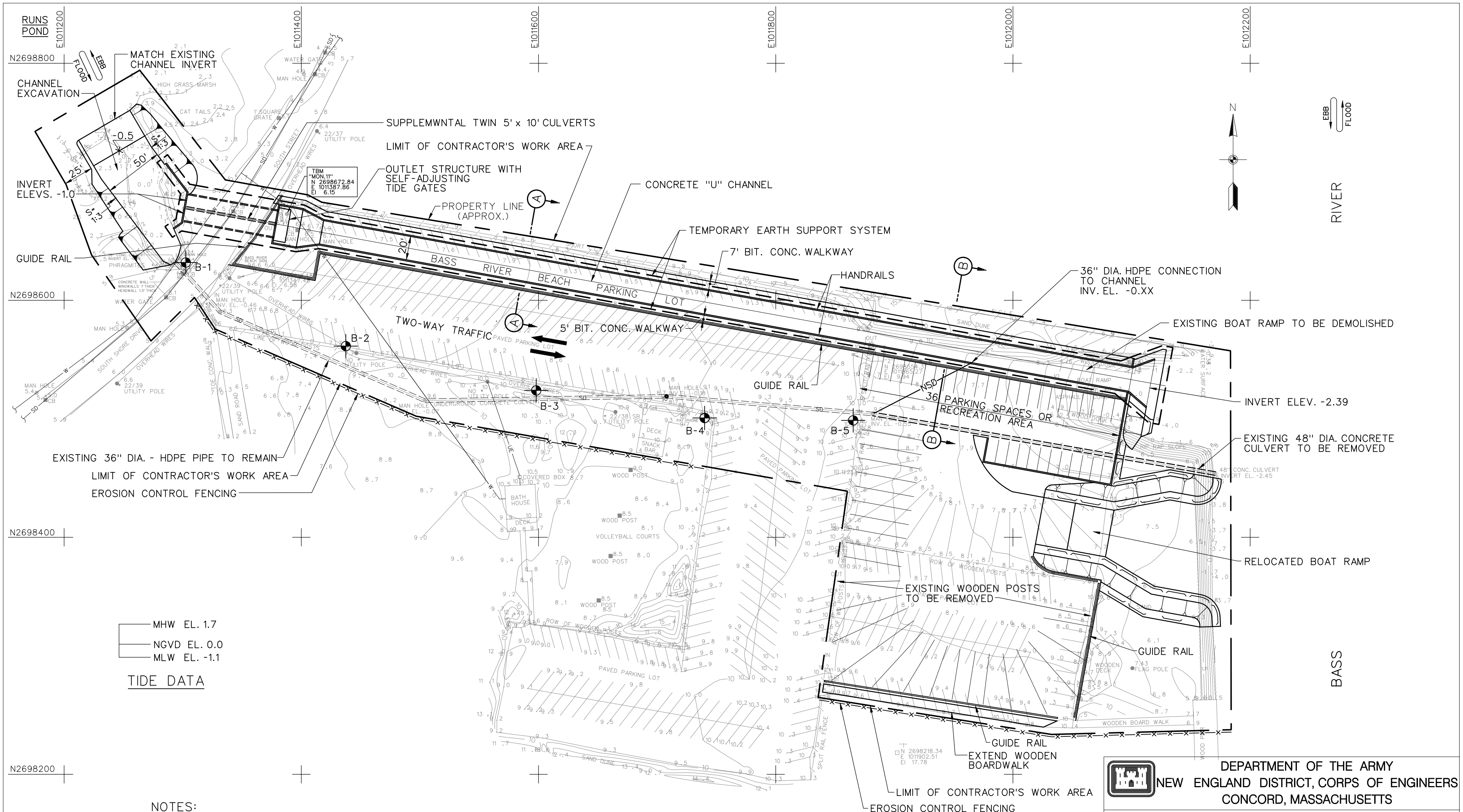
PLAN
SCALE: 1" = 40'

GRAPHIC SCALE
1" = 40' 40' 0 40' 80'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

AQUATIC ECOSYSTEM RESTORATION PROGRAM
RUN POND
YARMOUTH, MASSACHUSETTS
SUPPLEMENTAL TWIN 5' x 10' CULVERTS
GENERAL PLAN

FIGURE 6



NOTES:

1. COORDINATES REFER TO NORTH AMERICAN DATUM OF 1983 (N.A.D. 83).
2. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (N.G.V.D. 29), FORMERLY KNOWN AS MEAN SEA LEVEL OF 1929.
3. SEE NOTE ON C-1.

BASS RIVER BEACH
A.K.A. SMUGGLERS BEACH

PLAN
SCALE: 1" = 40'

GRAPHIC SCALE
1" = 40' 40' 0 40' 80'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

AQUATIC ECOSYSTEM RESTORATION PROGRAM
RUN POND
YARMOUTH, MASSACHUSETTS
CONCRETE "U" CHANNEL
PLAN

FIGURE 7

A fourth open channel alignment "D" was developed in conjunction with the town and is shown on Figure 7. This is the alignment that was selected for further evaluation and called Alternative 4.

Under this alternative (Alternative 4), two, 5’x10’ reinforced concrete box culverts would be installed from a new inlet headwall north of South Shore Drive to an outlet headwall just west of South Shore Drive. A 20-foot-wide by 11-foot-deep (average) concrete “U” channel would extend from the outlet headwall to its terminus at Bass River, running along the northern edge of the parking lot. Approximately 290 feet of the lower end of the existing partially collapsed culvert would be removed, and a 36” diameter culvert connection to the new “U” channel would be installed.

Similar to Alternatives 2 and 3, the culvert invert upstream of South Shore Road would be set at El. -1.0 ft. NGVD. The existing channel upstream of the headwall would also be excavated to El. –1.0 NGVD and widened to a 50-foot width for a distance of 100 feet upstream of the headwall. About 700 CY of silty-sand material would be excavated from the channel area and hauled to a disposal area. The invert elevation of the “U channel outlet would be set at El. –2.39 NGVD. The alternative would also include installation of self-adjusting tide gates at the outlet headwall for the twin box culverts to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond.

This alternative unlike the other alternatives results in the need to re-configure the existing town parking and recreations area. The existing boat ramp would be moved to the south. In addition the parking space layout would be changed and there would be a loss of about 190 parking spaces of the about 400 spaces available at the area.

A natural channel along this alignment was also considered, but the side slopes for a vegetated sandy embankment (2.5 H:1V) would result in doubling the channel top width and result in a greater loss of parking spaces and access to the remaining parking area.

This channel alternative is expected to increase the spring tide water surface elevation to about 2.0 ft. NGVD. This duplicates ocean levels and should be sufficient to increase flooding and restoration of the fringing wetland around the pond. The open channel will result in improved tidal exchange at the site with calculated volume exchange rates improving from an existing estimated value of 52 hours to 12 hours. It is likely that the pond bottom will be exposed (i.e. no water) during low tide.

<u>Other Features Common to Alternatives 2, 3, and 4.</u>

Alternatives 2, 3, and 4 include construction of a 0.4 acre shallow depression near Shore Drive at the southern end of the pond. (See Figure 8.) The depression would provide a refuge for fish and other aquatic life during low tide. This material will be used to construct a fringing wetland (about 0.3 acres) at the southern end of the pond using material excavated from the depression. The constructed saltmarsh would compensate for vegetated wetland excavated to create an approach channel to the new culverts. Alternatives 2, 3 and 4 also include excavation of ditches within vegetated wetlands to improve tidal exchange and promote growth of salt marsh vegetation.

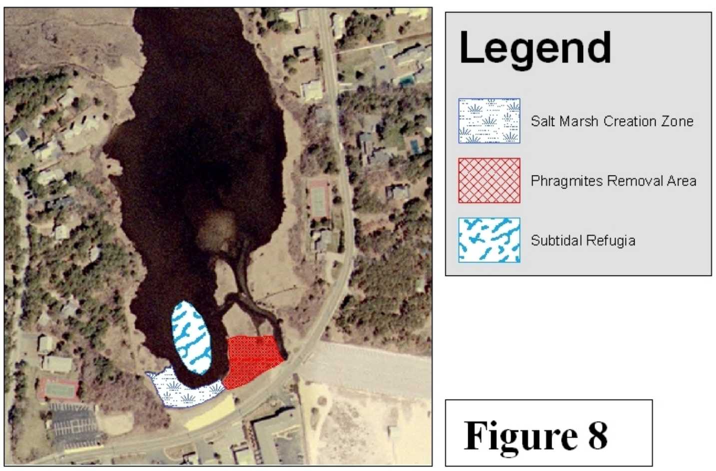


Figure 8

The alternatives include self-adjusting tide gates to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond. The alternatives also include adjustable stop logs to allow some surface water to be retained within the pond during low tide. Post construction adaptive management will determine how much surface water can be retained without sacrificing primary restoration objectives.

Improved tidal exchange provided by Alternatives 2, 3 and 4 will reduce the coverage of *Phragmites* but not completely eliminate it from the pond. A herbicide containing glyphosate (e.g., RODEO or AQUAMASTER) will be used to eradicate the remaining *Phragmites*.

3.3 Construction Cost of Alternatives

Feasibility level construction cost estimates were developed for the alternatives. These are shown in Table 8. Costs shown include the development of plans and specifications, the estimated construction contract cost, engineering and design during construction, construction supervision and administration, and real estate costs. The construction contract cost for each alternative was estimated using the Corps of Engineers MCACES cost estimating system. The estimates are based on feasibility level quantity estimates developed for the alternatives. The MCACES construction cost estimates are provided in Appendix D. In addition, real estate requirements for the alternatives were identified and preliminary value of the real estate required for the project developed. The Real Estate Report is included as Appendix E.

Table 8. Run Pond, Preliminary Construction Cost Estimates

COST ITEM	Add 48-inch Culvert	Twin Box Culverts	Culvert and Open Channel
Final Design and Plans & Specifications	$300,000	$300,000	$300,000
Construction Contract Cost (Nov 2007 dollars)	$2,823,815	$7,522,135	$6,420,838
Engineering and Design During Construction (4%)	$112,950	$300,890	$256,830
Construction Management (6%)	$169,430	$451,330	$385,250
O and M Manual	$10,000	$10,000	$10,000
Real Estate Costs	$205,000	$250,000	$410,000
FIRST COST	**$3,621,200**	**$8,834,400**	**$7,782,860**

Construction cost includes 15 percent contingencies.

3.4 Ecological Benefits

The proposed restoration of the salt pond and salt marsh would add to the Massachusetts goal of restoring coastal wetlands. These habitats are particularly valuable on Cape Cod because of the high development pressures in this area.

Coastal wetlands are ecologically and economically valuable. Marshes are important sources of food and habitat for fish and wildlife. Many species of wildlife particularly waterfowl directly consume the wetlands plants and their seeds. An even greater number of species including zooplankton, shrimp, snails, clams, worms, and forage fish eat the detritus from decaying plants. These species then become the primary food for commercial and recreational fish including bluefish, striped bass, and flounder.

The wetland and pond area can also provide critical habitat as spawning and nursery areas. In their larval stages, finfish and shellfish are close to their food source and in a sheltered environment.

Project benefits were assessed using the United States Fish and Wildlife Service Habitat Evaluation Procedures (HEP). This methodology calculates environmental benefits by using simple habitat models to predict suitability of the site for representative species. HEP models provide a “suitability index value” for the site for each species which is multiplied by acreage to provide “habitat units”. Habitat units are calculated for each alternative and provide a method to compare non-monetary project output.

Five ecological guilds were included in the habitat evaluation: benthic invertebrates, fish, waterfowl, tidal marsh birds, and birds which use scrub-shrub wetland habitat. Inclusion of these five guilds assures that all major habitat types affected by project alternatives are represented in the analysis. Models chosen for this study are summarized in Table 9. Soft-shell clam was selected to represent benthic invertebrates. Common mummichog was selected to represent the estuarine forage fish guild. Black duck was selected to represent the waterfowl guild. Yellow warbler was selected to represent songbirds that utilize scrub-shrub and scrub-shrub wetland habitat.

No single species model was appropriate to represent tidal marsh birds. This is because New England tidal marsh birds are a diverse assemblage of songbirds, wading birds, and shorebirds with divergent habitat requirements. Instead of using several single species models, a simple habitat suitability model for bird species diversity was developed from data collected by Benoit and Askins (1999). The model relates species richness of tidal marsh bird communities to vegetation type.

Table 9. Habitat Models Included in HEP Analysis

Guild	Representative Species or Model	Habitat Type(s) Evaluated by Model			
		Open Water	Inter-tidal	emergent marsh	scrub-shrub
Benthic	Soft-shell Clam	X	X		
Fish	Common	X	X		
Waterfowl	Wintering Black Duck	X	X	X	
Marsh Birds	Guild Model			X	
Songbirds	Yellow Warbler				X

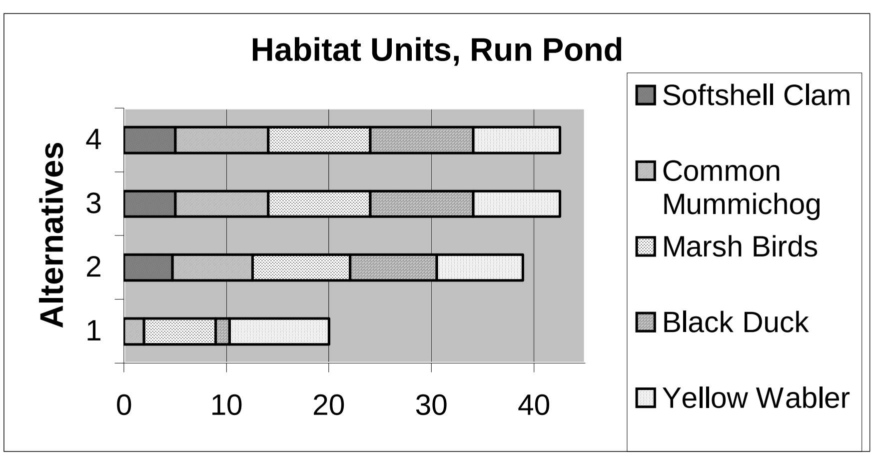
The evaluation was conducted using water quality data collected in 2001 and other field observations between 2001 and 2004, the results of hydraulic modeling (Appendix A), and professional judgment. GIS techniques were used to project changes in plant community cover type associated for each alternative. Vegetation Maps were developed for no action and each alternative based on site visits. Benefits were projected as average annual benefits over a 50-year post construction time period.

The changes expected and the HUs calculations are discussed in detail in Appendix C and summarized below. Alternative 2 yields an increase of 18.9 HUs relative to the No Action Alternative. Alternatives 3 and 4 yield an increase of 22.6 HUs relative to No Action. With the alternatives (2, 3, or 4) substantial improvements are achieved in benthic, fish and waterfowl habitat and increases in habitat units are estimated at about 5 times the No Action alternative. Marsh bird habitat increases by about 25 percent and song bird habitat decreases slightly.

Table 10. Run Pond Habitat Analysis Summary

Representative	Existing	No Action	Alt 2	Alt 3	Alt 4
		(25 YR AVER)			
	HU's	HU's	HU's	HU's	HU's
Soft-shell Clam	0	0	4.74	5.03	5.03
Common Mummichog	5.88	1.96	7.82	9.08	9.08
Marsh Birds	8.02	7	9.52	9.94	9.94
Black Duck	1.7	1.35	8.46	10.04	10.04
Yellow Warbler	7.72	9.7	8.37	8.46	8.46
TOTAL	23.32	20.01	38.91	42.55	42.55
TOTAL Rounded		20	38.9	42.6	42.6

Figure 9. Habitat Units Run Pond



3.5 Cost Effectiveness and Incremental Cost Analysis

In order to identify the most cost effective alternative, the costs of the alternative restoration plans are compared with the environmental benefits, within the framework of an incremental cost analysis. An incremental cost analysis examines how the costs of additional units of environmental output increase as the level of environmental output increases. For this analysis, the environmental outputs are measured in habitat units. The analysis is in accordance with IWR Report 95-R-1, Evaluation of Environmental Investments Procedures Manual-Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995; and ER 1105-2-100, Planning Guidance Notebook, Section 3-5, Ecosystem Restoration, April 2000. The program, IWR Planning Suite, developed for the Institute for Water Resources (IWR) in 2006, was used to conduct the analysis.

An incremental cost curve can be identified by displaying cost effective solutions. Cost effective solutions are those increments that result in the same output, or number of habitat units, for the least cost. An increment is cost effective if there are no others that cost less and provide the same, or more, habitat units. Alternatively, for a given increment cost, there will be no other increments that provide more habitat units at the same, or lower, cost.

Management plans to improve environmental conditions at Run Pond include different culvert and channel construction restoration scenarios. Project description, project cost, and the number of habitat units created by each plan are shown in Table 11. Costs are discounted at an interest rate of 4 7/8 %. This interest rate, as specified in the Federal Register, is to be used by Federal agencies in the formulation and evaluation of water and land resource plans for the period October 1, 2007 to September 30, 2008. The project economic life is considered to be 50 years.

Table 11. Alternative Economic Cost and Output

Alternative	Description	Project Cost	HU
		($000)	
1	Without Project	0.0	0
2	Construct a 48-inch Culvert	3,721.4	18.9
3	Construct Two 5 X 10 feet Box Culverts	8,987.8	22.6

4	Construct a 20 foot wide Channel	13,249.3	22.6

In Table 11, Column 2 lists each alternative. Alternative 1 is the without project, or no action, alternative. Alternative 2 provides for the construction of one 48-inch culvert. In Alternative 3, two 5x10 foot box culverts would be constructed. In Alternative 4, a 20-foot wide channel and culverts under the road would be constructed. Habitat units (HU) are average annual equivalents and are increments over the without project alternative. These alternatives, or increments, are mutually exclusive and cannot be combined. The derivation of project economic cost is described below.

Economic project cost derivation is shown in Table 12. First cost includes all contingencies, overheads, real estate and design costs (Plans & Specifications). Interest during construction (IDC) is then calculated assuming a construction period of 6 months for Alternatives 2 through 4. This is an economic cost and not a financial cost. It needs to be estimated for purposes of project justification; however it is not a financial cost that will need to be cost shared. Essentially, IDC represents the opportunity cost of funds tied up in investments, before these investments begin to yield benefit. Once project benefit starts, IDC stops.

Table 12. Alternatives Economic Costs ($000).

Alternative	First Cost	IDC Cost	Investment Cost	Monitoring Cost	O&M Cost	Recreation Loss	Project Cost
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	3,621.2	37.0	3,658.2	26.0	37.2	0.0	3,721.4
3	8,834.3	90.2	8,924.5	26.0	37.2	0.0	8,987.8
4	7,782.9	79.5	7,862.4	26.0	37.2	5,323.7	13,249.3

Combining total first cost and IDC results in investment cost; annual operation and maintenance (O & M), monitoring cost and the value of lost recreational opportunities are then added to investment cost to arrive at total project cost. Annual O & M cost for each alternative is $2,000.This annual cost is multiplied by a discount factor of 18.61425 to yield a present value of $37,200 for the period of analysis. The discount factor is one per period for 50 years with an interest rate of 4 7/8 %. Monitoring cost is estimated to be $10,000 in years 2, 3, and 4 of project life. The discount factor is 2.60275and multiplying by $10,000 yields $26,000. The loss of recreation value for Alternative 4 is shown in Table 13 and described in the following paragraph.

Table 13. Recreation Value Bass River Beach

Item	Alternative 4	Without Project
Parking Spaces	0	190
Turnover	2.0	2.0
Passengers / car	2.7	2.7
Weekdays Available	31.5	31.5
Weekends Available	28	28
% Days in Use	0.75	0.75
Weekdays in Use	24	24
Weekends in Use	21	21
User Days	0	45,828
Value per user day	$6.25	$6.25
Recreation Value ($000)	0	286
Recreation Value Loss	286	0

Table 13 displays the assumptions and data used to estimate the loss of recreation value associated with Alternative 4. This alternative would result in the loss of 190 parking spaces that in turn would result in the loss of 45,828 user days annually. The value of a user day is estimated to be $6.25 (FY 2008 recreation values). Multiplying the value per user day and the number of user days results in the annual value lost with Alternative 4. Previous Corps studies involving recreation opportunities in Yarmouth have shown that there is excess demand for beach space in the area. Thus the displaced beach goers would not be able to find other opportunities nearby. If there were such opportunities the value lost would be the difference in unit day values between the Bass River Beach and the other beaches. The derivation of the unit day value follows Corps methodology and is an evaluation technique that assigns points based on established criteria and then translates the point totals into dollar values. Value is established for the summer beach season. Information on parking space turnover and users per car was obtained from the Yarmouth Recreation Department. The annual loss of $286,000 over the period of analysis has a present value of $5,323,700 (18.61425 x $286,000).

Figure 10a displays all cost effective plans and best buy plans. The vertical axis represents thousands of dollars. Plans under consideration are mutually exclusive and thus cannot be combined in the analysis. The incremental analysis identified three (out of a possible 4) alternatives as cost effective plans. Each plan in Figure 10a is labeled with its corresponding output (HU) and cost. Best buy plans are a subset of cost effective plans. For each best buy plan there are no other plans that will give the same level of output at a lower incremental cost. In this case each cost effective plan is also a best buy plan. The best buy plans in Figure 10a are denoted with a triangle. Alternative 4 is not cost effective. By referring to Table 10a, it can be seen that Alternative 4 provides the same number of habitat units as Alternative 3, but costs more. Thus Alternative 4 is not cost effective.

Figure 10b shows best buy plans that comprise the incremental cost curve. As in Figure 10a, the horizontal axis represents habitat units created by each project. However, the vertical axis represents the incremental cost per incremental output as output increases with project size. The units on the vertical axis are thousands of dollars. Best buy plans are a subset of cost effective plans. For each best buy plan there are no other plans that will give the same level of output at a lower incremental cost. There are three best buy plans.

Increments that comprise the best buy plan curve are alternatives 1, 2 and 3, the without project or no action alternative; the construction of a 48-in culvert; and the construction of two-5x10 foot box culverts. The best buy plan curve is the incremental cost curve. Incremental cost and incremental output are the changes in cost and output when the cost and output of each successive plan in terms of increasing output are compared. Incremental cost per output is the change in cost divided by the change in output, or incremental output, when proceeding to plans with higher levels of output. Table 14 shows incremental cost for each best buy alternative.

Table 14. Incremental Cost Curve

						Inc. Cost
			Ave.	Inc.	Inc.	per
Alternative	HU	Cost	Cost	Cost	HU	Inc. HU
		($000)	($000)	($000)		($000)
1	0.0	0.0				0.0
2	18.9	3,721.4	196.9	3,721.4	18.9	196.9
3	22.6	8,987.8	397.7	5,266.4	3.7	1,423.3

In the incremental cost curve (last column in Table 14), incremental cost per unit increases with output, or habitat units. Development of the incremental cost curve facilitates the selection of the best alternative. The question that is asked at each increment is: *is the additional gain in environmental benefit worth the additional cost*? In this study, the incremental cost curve consists of three points represented by Alternative 1, Alternative 2 and Alternative 3. Alternative 1 is the without project condition, or no action alternative. Alternative 2 provides for the construction of a 48-inch culvert. This alternative would result in 18.9 HU, with an incremental cost of $196,900 per HU. Alternative 3 calls for the construction of two-5x10 foot box culverts that would provide 22.6 HU at an incremental cost of $1,423,300 per HU. This analysis shows that Alternative 2, the addition of the 48-inch culvert produces about 84 percent of the total environmental benefits, while a significant increase in cost is required to obtain the remaining 16 percent achieved by Alternative 3.

3.6 Selection of Proposed Project

Information used in selecting the recommended plan or National Ecosystem Restoration (NER) plan included consideration of the plans outputs (benefits) and costs, acceptability to the public and resource agencies, and any impacts associated with the alternatives. The goal is to select an NER plan that reasonably maximizes the environmental net benefits.

Table 15. Comparison of Alternatives

	Alt 1 - No Action	Alt 2 - add new 48-inch culvert	Alt 3. add two box culverts	Alt 4. open channel
Restoration Benefit (HUs)	0	18.9	22.6	22.6
Cost Effective Plan	yes	yes	yes	no
Local Support	no - does not solve problem	yes	no - cost exceeds sponsors expected capability to cost share	no- results in significant loss of town parking at town beach
Meets Project Objectives and Constraints (1)	no	yes	yes	no - long- term loss of parking
Ecological Considerations	Continued degradation of wetland	Improves about 30 acres of coastal wetland by increasing tidal exchange	Improves about 30 acres of coastal wetland by increasing tidal exchange	Improves about 30 acres of coastal wetland by increasing tidal exchange
Cultural Resources	no significant impacts	no significant impacts	no significant impacts	no significant impacts

(1) Project Objectives and Constraints:

- Improve water quality within pond to restore aquatic habitat and reduce nuisance algal blooms. Key concerns are low dissolved oxygen and high nutrient levels during summer months.
- Increase salinity in emergent wetlands to restore saltmarsh vegetation.
- Eradicate *Phragmites*, an invasive emergent plant that threatens to displace *Spartina*, cattail, and other emergents.
- Maintain some permanent open water during low tide to provide a refuge for estuarine fish and invertebrates.
- Avoid long-term adverse impacts to the town beach and parking area.
- Avoid increased flooding to structures near Run Pond.
- Incorporate the request of the Local Sponsor to keep any proposed solution within the land currently owned by the town.

In considering the alternatives, The No Action Alternative was eliminated as it does not meet the study objectives. The open channel, Alternative 4 was eliminated because it was not cost effective (See Section 3.5); it fails to reasonably maximize benefits and results in a significant loss in parking spaces at the town beach.

Both Alternative 2 and 3 are best buy plans and meet the project objectives. However, although Alternative 3 yields more habitat units, these additional units require a significant increase in the project cost of about 2.3 million dollars. Most of the project benefits can be achieved at a lower cost with Alternative 2. Alternative 2 provides a substantial increase in the number of habitat units at reasonable cost. Alternative 2 was selected as the NER plan.

Alterative 2 is acceptable to State and local governments. There is broad based public support for the restoration of coastal environments. The proposed project is a complete, stand alone, project. To assure success, the plan includes provisions for monitoring, adaptive management, and maintenance.

4.0 SIGNIFICANCE OF RESOURCES TO BE RESTORED

An analysis of significance helps to determine whether the value of the benefits of the proposed project is worth the costs incurred to produce them. The significance analysis includes an assessment of the institutional, public, and technical justification.

4.1 Institutional Recognition

The federal significance of estuarine habitat found at Run Pond is recognized in the Clean Water Act, the Estuary Restoration Act, the Coastal America Program, and many other Federal and State initiatives. Federal interest in invasive species control (*Phragmites*) is institutionally recognized by Executive Order 13112 of February 3, 1999 -- Invasive Species. Restoration of black duck habitat is recognized by the North American Waterfowl Management Plan, Black Duck Joint Venture (http://www.qc.ec.gc.ca/faune/sauvagine/html/historic.html).

4.2 Public Recognition

Poor water quality and loss of salt marsh at Run Pond has concerned the Town of Yarmouth Natural Resource Agency for many years. Recently the local home owner's group has become increasing involved with the Agency in advocating for a solution to restore tidal flow to Run Pond. The plan will address all major environmental problems identified in the study area. These include low dissolved oxygen levels in surface waters, excessive growth of filamentous algal mats, and proliferation of *Phragmites*. Fish passage will also be enhanced by the addition of the new culvert. The Alternatives would all have some additional social benefits. Improved habitat quality may allow the pond to support a recreational soft shell clam fishery and would likely increase recreational use of the Run Pond. Odor caused by decaying algal mats is expected to decline and reduction of this nuisance will improve wetland aesthetics

4.3 Technical Recognition

Technical recognition means that the resources qualify as significant based on an objective scientific evaluation. Significance may vary with spatial scale. For Run Pond, significance was evaluated on the local watershed scale and regional landscape scale. Corps planning guidance recommends description of technical significance in terms of one or more of the following ecological concepts: scarcity, representativeness, status and trends, connectivity, critical habitat, and biodiversity. Application of each of these concepts to Run Pond is discussed below.

<u>Scarcity</u>: Scarcity is a measure of the relative abundance of a resource within a geographic area. Coastal ponds are rare on Cape Cod and in Massachusetts and are a highly valued resource. Many of the remaining ponds have problems similar to those exhibited by Run Pond (i.e. eutrophication, invasive species, and loss of historic hydrological connections with the ocean). A large percentage of Massachusetts's salt marsh has been lost to development and the remaining marsh is a highly valued and protected resource.

<u>Representativeness</u>: This is a measure of the resource's ability to exemplify its habitat type. After construction Run Pond would function as a representative tidal estuary in most ways. The culverts would not fully restore fish passage however, so this aspect of estuarine function would remain degraded. Alternative 4 would come closest to restoring a fully functional tidal system by connecting the pond to the Bass River estuary by a channel. This alternative is not recommended, however, because of its very high cost.

<u>Status and Trends</u>: This concept involves evaluating how the resource has been altered over time, its current conditions, and prospects for the future. Run Pond habitat is currently highly degraded, and remains in decline due to eutrophication and proliferation of *Phragmites*. Without action, conditions are expected to worsen considerably, with further loss of aquatic habitat value due to growth of algal mats and expansion of *Phragmites* into adjacent emergent wetland. Corps policy guidance indicates that sites with declining trends are more significant than sites that are recovering without human intervention. The Run Pond restoration can be considered technically significant because without human intervention there is no potential for recovery of the resource and every reason to expect continued degradation.

Connectivity: This concept involves the degree of linkage of resource areas within a watershed or larger landscape content. The value of natural areas is enhanced by existence of habitat corridors that allow for movement and dispersal of native species between resource areas. Restoration alternatives that improve connectivity are considered technically significant. Installation of culverts proposed under Alternative 2 would improve connectivity of the pond with the Bass River Estuary, enhancing passage of both fish and invertebrates.

Limiting Habitat: This is habitat that is essential for the conservation, survival, or recovery of one species listed as rare or endangered under the federal endangered species act or other significant non-federally listed species. Following restoration, Run Pond should provide improved wintering habit for black duck, a species in decline throughout most of its range in the eastern Untied States. Restoration of Run Pond, however, is unlikely to provide habitat for any state or federally listed species or anadromous fisheries.

Biodiversity: The concept of biodiversity concerns the number of the species found in a community (species richness) and the distribution of individuals among species (i.e. how evenly the total number of individuals is divided among species). Restoration alternatives that improve biodiversity (either species richness or evenness) are considered technically significant. By reducing the prevalence of algal mats, the plan would likely increase diversity of the benthic invertebrate community. The plan would also eradicate *Phragmites*, increasing the biodiversity (species richness) of emergent wetland communities.

5.0 PROPOSED PROJECT

5.1 Project Description

The proposed project (Alternative 2) involves installation of about 900 ft. of new 48-inch diameter culvert to supplement flow through the existing 36” diameter culvert to increase tidal exchange. The new culvert would extend from a new headwall north of South Shore Drive through the town public parking area to the outlet near Bass River. As the culvert is located beneath the surface of the existing parking lot, no parking spaces would be lost.

The existing channel upstream of the Run Pond headwall would be excavated and widened to about 50 ft. for a distance of about 100 feet upstream of the headwall. About 700 cubic yards (CY) of silty-sand material would be excavated from the channel area and hauled to a disposal area. The lower 315 feet of the existing culvert would be replaced with a new 36” diameter culvert parallel to the new 48” culvert to the outlet near Bass River.

The alternative includes construction of a shallow depression near Shore Drive (0.4 acres) at the southern end of the pond. The depression would provide a refuge for fish and other aquatic life during low tide when much of the pond bottom will be exposed. About 0.3 acres of vegetated salt marsh would be constructed at the southern end of the pond using material excavated from the depression. The constructed saltmarsh would compensate for vegetated wetland excavated to create an approach channel to the new culvert. The proposed plan also includes excavation of small ditches within vegetated wetlands to improve tidal exchange and promote growth of salt marsh vegetation.

The proposed plan includes self-adjusting tide gates to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond. It also includes adjustable stop logs to allow some surface water to be retained within the pond during low tide. Post construction adaptive management will determine how much surface water can be retained without sacrificing primary restoration objectives.

Improved tidal exchange provided by the proposed project will reduce the coverage of *Phragmites* but not completely eliminate it from the pond. An herbicide containing glyphosate (e.g. RODEO or AQUAMASTER) will be used as a management measure to eradicate the remaining *Phragmites*.

5.2 Fully Funded Proposed Project Costs

The Table 16 shows the estimated fully funded proposed project costs. Construction cost estimates will be refined during final design. Estimated construction costs are detailed in Appendix D. Estimated Real Estate costs are detailed in Appendix E. Costs include planning, design, and construction costs, applicable contingencies and escalation to 2010.

This project is proposed for construction under the Corps', aquatic ecosystem restoration program authorized in Section 206, of WRDA 1996, Public Law 104-303, as amended. This is a continuing authority and project implementation costs and short term monitoring are cost shared by the Federal government (65 percent) and Local Sponsor (35 percent).

5.3 Applicable Permits and Regulatory Reviews

The following permits are required for project implementation.

<u>Clean Water Act, Section 404(b)</u> - 33 USC 1251 et seq.• Section 404(b)(1) evaluation provided as an Attachment to this report. The Corps will provide the 404(b)(1) evaluation and approval.

<u>MA Water Quality Certification</u> for Discharge of Dredged, Fill Material, Dredging, and Dredged Material Disposal in Waters of the U.S. within the Commonwealth (MA administration of Federal Clean Water Act Section 401 as provided for in 21 MGL 26-53; 314 CMR 9.00.) This certification will be obtained by the Corps.

<u>MA Coastal Zone Management Act</u> as provided for in 301 CMR 21 - CZM consistency determination from MA CZM pursuant to the Coastal Zone Management Act. The Corps of Engineers will request this determination.

Table 16. Run Pond, Total Project Cost Summary
(Civil Works Cost Tables are included in Appendix D)

CIVIL WORKS FEATURE AND SUB-FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	Fully Funded Project Estimate, Includes Escalation to 2010 ($K)
CONSTRUCTION CONTRACT COST	2,455	491	20	2,946	3,087
LANDS AND EASEMENTS	164	41	25	205	214
FEASIBILITY STUDY COSTS	*completed in 08*			310	310
PLANNING ENGINEERING AND DESIGN					
Project Management	45	9	20	54	55
Plng & Env. Compliance	20	4	20	24	24
Eng Design, VE, ITR, Contracting	170	34	20	204	209
Eng. & Plng. During Construction	60	12	20	72	75
Project Operations: O & M Manual	15	3	20	18	18
SUBTOTAL	**310**			**372**	**381**
CONSTRUCTION MANAGEMENT					
Construction Management	80	16	20	96	100
Project Monitoring (3 years)	30	6	20	36	38
Project Management	40	8	20	48	50
SUBTOTAL	**150**			**180**	**188**
TOTAL	**3,079**			**3,703**	**4,180**
Federal Share				**65%**	**2,717**
Non-Federal Share				**35%**	**1,463**

5.4 Construction Window

Construction will not occur during the summer. During the summer shellfish, other benthic organisms, and finfish are spawning and biological activity is highest. In addition, during this time the parking area at the town beach is heavily used for recreational purposes. Avoiding summer construction will minimize biological impacts and avoid recreational impacts.

5.5 Implementation Schedule and Short-Term Monitoring

The following is an estimated timeline for the project. The non- Federal sponsor will be required to sign a Project Cooperation Agreement during the Engineering an d Design phase and provide funds as appropriate for cost sharing of the design and construction.

<u>Engineering and Design Phase, Winter 2008 to Spring 2009</u>

- Corps prepares final design and plans and specifications for project

<u>Pre-Construction, Summer 2009</u>

- Sponsor obtains LERRD for project and provides certification to Corps
- Corps issues bid documents and selects construction contractor
- Corps awards construction contract

<u>Construction Phase, September 2009 to Spring 2010</u>

- Corps contractor performs construction with Corps oversight

<u>Post Project Monitoring/Adaptive Management (3 Years), 2010 and 2013</u>

- Corps conducts a three year monitoring program to document salt marsh/pond restoration success and implement Phragmites control measures, as required.

5.6 Local Sponsor Responsibilities

<u>Cost sharing.</u> The Local Sponsor is required to provide 35 percent of the implementation cost of a Section 206 project. At this time the costs for the studies, design, plans and specifications and construction for the proposed restoration project are estimated as shown in Table 16.

<u>Real Estate.</u> At the time of project construction the non-federal sponsor will be required to obtain any lands, easements, right-of-ways, relocations or disposal sites

(LERRD) required for the project. This LERRD is detailed in the attached Real Estate Report Appendix E.

Long-Term Operation and Maintenance of the Project. The Local Sponsor is responsible for long-term maintenance of the project. Local Sponsor is responsible for providing periodic maintenance as needed to prevent clogging of the inlet to the pond and monitor and treat as necessary to prevent *Phragmites* re-growth.

Other Items. This section lists permits that the state or local governments may impose on the sponsor. These requirements do not apply to the Corps and are not funded nor performed by the Corps for the sponsor. They are listed in this report for information purpose only.

- MA Environmental Policy Act (MEPA) Sets forth a process of environmental impact analysis and public review of State projects. Applicable to projects directly undertaken by State agencies; private projects seeking permits, funds or lands from the State; and any projects that will dredge, fill or alter greater than 1 acre of wetland. Review is based upon an Environmental Notification Form (ENF). Upon approval by the MA Office of Environmental Policy Act, the project is issued a Certificate.

- Waterways License 91 MGL 1.00 et seq.; 310 CMR 9.00. Requires Waterways License from MA DEP, Division of Waterways for activities that will occur below mean high water in flowed or filled tidelands. The Town will apply for this permit.

- MA Wetlands Protection Act (WPA) 131 MGL 40; 310 CMR 10. The proposed restoration entails otherwise prohibited actions in resource areas; however the restoration activities will result in substantial net ecological benefits to the resources protected under the WPA. When a detailed design has been completed, a Notice of Intent will be submitted by the Town of Yarmouth to the Conservation Commission and an Order of Conditions will be prepared for the project.

- MA Coastal Wetlands Restriction Act - Authorities: M.G.L. c. 130, § 105: Protection of Coastal Wetlands; 310 CMR 12.00: Adopting Coastal Wetlands Orders.
- The purpose of the Coastal Wetlands Restriction Act is to preserve public health, safety and welfare, private property, wildlife, and marine fisheries by the adoption, after suitable public comment, of orders imposing restrictions on coastal wetlands. Regulated activities in restricted wetlands include dredging, filling, removing, otherwise altering, or polluting coastal wetlands. Coastal wetlands restriction orders are recorded at the Registry of Deeds. While this program is not currently active, a number of Orders have been recorded and are still in effect. In 1980, orders were recorded for the wetlands associated with Run Pond. Proposed alterations to registered wetlands are reviewed by local Conservation Commissions through the Notice of Intent (NOI) process, as described above under the Wetlands Protection Act.

- Local Bylaws. The Run Pond project will be subject to review under the Town of Yarmouth Wetland Protection Bylaw. The bylaw is administered by the town's Conservation Commission.

6.0 ENVIRONMENTAL CONSEQUENCES

6.1 Hydrology and Flooding

Hydrology

In order to improve the condition of the fringing wetland and to improve the water quality of the pond both an increase in tide water surface elevation and an increase in tidal exchange are required. A one-dimensional hydrodynamic computer model was used to model flow and water levels in the pond (See Appendix A). The time to drain and fill one pond volume was evaluated (See Table 17). Under existing conditions it takes approximately two days for the volume of Run Pond to be replaced. Alternatives 2, 3, and 4 reduce the replacement time from 52 hours to 11 – 14 hours, draining virtually the entire pond during each 12 hour tide cycle.

Table 17. Estimated Time Unit to Drain and Fill One Pond Volume

Run Pond	Alternative 1, No Action	Alternative 2, add 48-inch culvert	Alternative 3, Two 5 by 10 ft. box culverts	Alternative 4, Open channel
Time unit to drain and fill one pond volume	52 hours	14 hours	11 hours	12 hours

Flooding

Available survey information was studied to determine the elevations of low-lying roads and properties adjacent to the pond. Analysis was conducted to determine whether any of the proposed culvert alternatives would cause flooding to the low-lying properties adjacent to the salt marsh during storm events (see Appendix A).

South Shore Drive, which runs along the southern end of the pond, has a minimum elevation of 5.7 ft NGVD. The town parking lot, the Bass River Beach, and various hotels are located south of South Shore Drive. At the narrowest and lowest point, approximately 700 ft of beach separates the ocean from the pond. This portion of beach is at a low elevation, ranging from 5.5 ft to 6.2 ft NGVD. As such, when tide levels of greater than approximately 6 ft NGVD (roughly a 11-year tidal event) are experienced, flooding of the pond will likely happen regardless of which culvert is selected because the wave overtopping will likely flood the beach, pass over the road and cause inundation of the salt marsh. Tide levels corresponding to the 100-yr and the 50-yr frequency flood events are 10.0 ft NGVD and 8.4 ft NGVD, respectively. These tide levels are higher than the adjacent beach, and floods of this magnitude would likely flood the entire pond and surrounding area.

The 10-yr frequency tide level and 5-yr frequency rainfall event was modeled for Alternative 2, leaving the existing culvert in place and supplementing it with a 48-inch culvert with an upstream invert of -1.0 ft NGVD. With this condition, the maximum computed water level in the salt marsh was 3.4 ft NGVD, which is lower than the elevations of the surrounding homes and roads. However, the water level in the marsh at the end of the 10-yr tide event is approximately 2.7 ft NGVD, higher than the average water level. If the tide level was to remain elevated for more than one tide cycle, which would hinder draining of the pond, it is likely that water levels in the pond would rise above the elevations of the low-lying properties.

A 1-yr frequency tide level and a 5-yr frequency rainfall event were simulated for the two 5 ft by 10 ft box culverts (Alternative 3) and a 5 ft by 20 ft open channel (Alternative 4). This condition produced a maximum water level in the salt marsh of 3.6 ft NGVD, which is lower than the elevations of the surrounding homes. A 10-yr frequency tide level and a 5-yr frequency rainfall event were simulated for Alternatives 3 and 4. This condition produced a maximum water level in the salt marsh of 5.4 ft NGVD, which is higher than the elevations of some of the surrounding roads and homes. With this condition, a 450 ft long stretch of Run Pond Rd will likely flood, the western end of Crescent Court will likely flood, and it is possible that the lower level of a split level home located at Crescent Court will flood.

Based on these findings, tide gates are included in the proposed project to prevent an increase in flooding during storm events. With the gates in place and properly operated, the flood risk to low lying properties would be no greater than under existing conditions.

6.2 Water Quality

Temporary Construction Impacts

Excavation of the outlet channel and subtidal pool will increase suspended sediment in Run Pond near the work area. A silt curtain will be installed to minimize movement of sediment within the pond and suspended sediment concentration should decrease to near background within several hundred feet of the work area. To avoid impacting the Bass River, stop log structures on the outlet culverts will be closed while excavation is underway. This will prevent suspended sediment from reaching the Bass River during outgoing tides. Culverts will be reopened during off hours to allow normal tidal flushing.

Some turbidity will also be generated during salt marsh construction. Silt barriers will be installed at the base of the constructed marsh to reduce sediment transport.

Excavation of tidal channels and pools within marsh areas will increase suspended sediments near the work area. Levels should return to background within a few hundred feet of the work area and should have no impact on water quality of Run Pond or the Bass River. It will not be necessary to close outlet culverts during construction of the tidal channels or pools.

Long-term Impacts

The intent of this project is to improve the tide exchange to the pond to increase salinity and dissolved oxygen (DO) concentrations for habitat restoration. All of the alternatives with the exception of the No Action Alternative substantially increase the volume of flow and tidal exchange to the marsh area and should dramatically improve water quality.

The two 5 ft by 10 ft box culverts and 5 ft by 20 ft open channel are the only two alternatives that allow the water level in the marsh to rise to the level of the ocean tide. These two alternatives also provide the largest volume of saltwater exchange between the pond and the ocean. The smallest culvert needed to cause a noticeable fluctuation in water level is a 48-inch HDPE culvert with an upstream invert of -1.0 ft NGVD. Although the 48-inch HDPE culvert does not provide the level of flushing that is seen with the two 5 ft by 10 ft box culverts and 5 ft by 20 ft open channel, this alternative allows approximately 50% more water to enter the marsh and 85% more water to leave the marsh than the existing culvert does.

A cursory water quality analysis was conducted of Run Pond to determine if increasing the tidal flushing will discourage the growth of aquatic vegetation (algae) and improve the water quality conditions of the pond. Water quality samples collected by the Corps on 18 July 2001 and 8 August 2001 measured a high presence of total nitrogen and phosphorous, which promotes the growth of aquatic vegetation. The source of these nutrients is not known and is likely from a combination of non-point source inputs. It is anticipated that the increased frequency of tidal exchange will decrease nutrient levels in Run Pond and therefore, improve the water quality conditions in the open water portion of the site.

6.3 Habitat

Currently Run Pond is a true pond and remains inundated throughout the tidal cycle. All of the alternatives would convert most of the pond to brackish intertidal habitat. A depression in the existing pond bottom is to be created near the south end of the pond and would remain inundated throughout the tidal cycle. Although detailed topographic information is lacking, it is possible that there are some natural depressions within the pond and that these will remain inundated at low tide. Permanent lower pools may also occur within the channels that flow into the pond from the west and north.

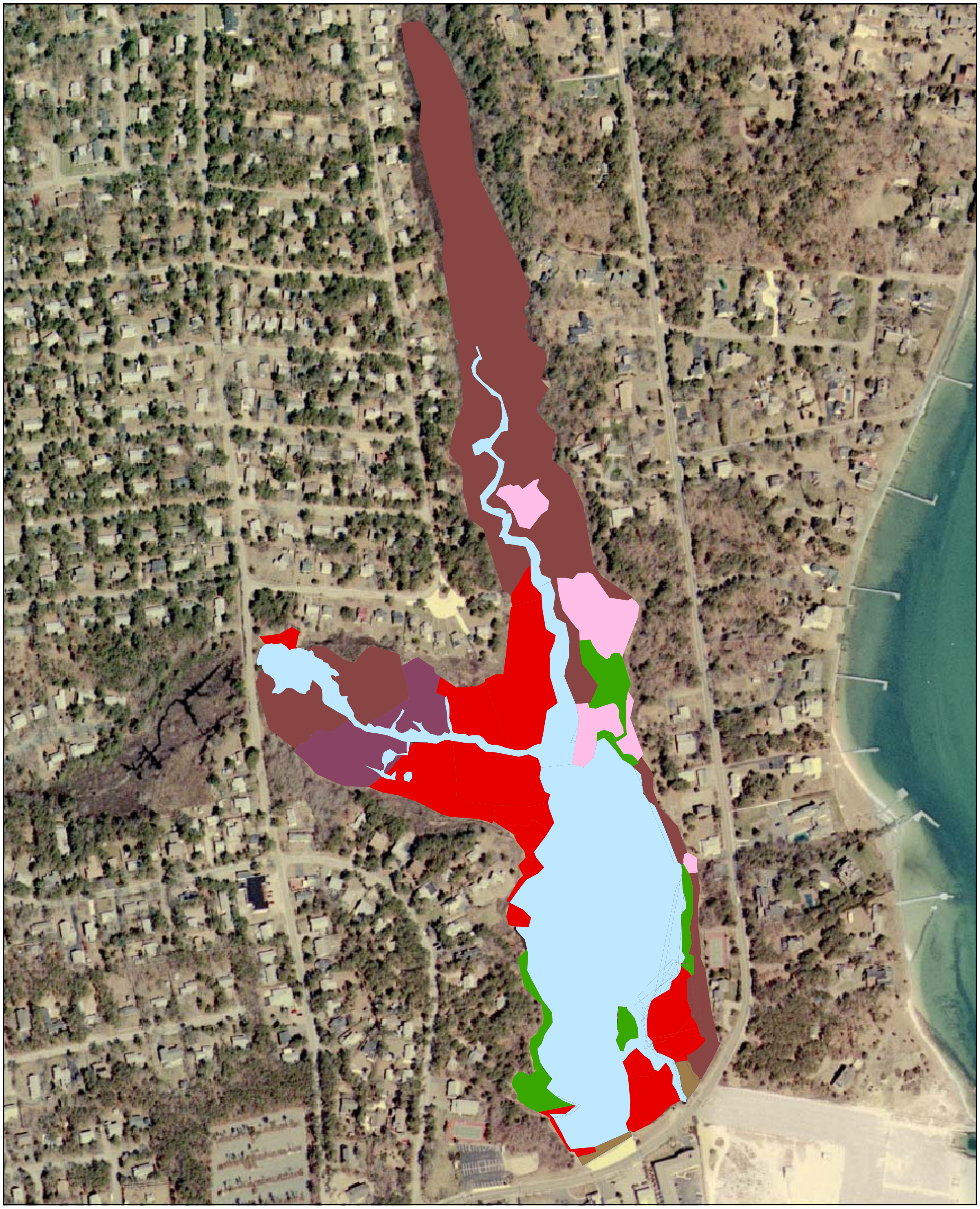
Increased tidal flushing will lead to some additional scour near the outlet channel, converting silty sand substrate in some areas to a coarser sand and/or gravel substrate.

6.4 Biological Resources

<u>Vegetation.</u>

Vegetation maps Figures 4, 11, 12, and 13 show existing vegetation at Run Pond and predicted distribution of vegetation for the No Action alternative and Alternatives 2, 3 and 4. Without action, over the next 50 years, *Phragmites* is expected to gradually expand into marsh now dominated by *Spartina*, cattail, and purple loosestrife. Over the longer term, areas dominated by *Myrica* and other low shrubs are also at risk.

Alternatives 2, 3, and 4 will increase salinity and flushing of Run Pond, favoring growth of *Spartina patens*, *Spartina alterniflora* and other salt tolerant species relative to



Legend

0 412.5 825 1,650 2,475 Feet

- Phragmites
- Typha
- Typha/Lythrum mix
- disturbed area
- new channel
- open water
- salt marsh
- shrub
- subtidal

Run Pond
Yarmouth, Mass

Vegetation Type
Alternative 1
No Action

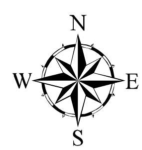
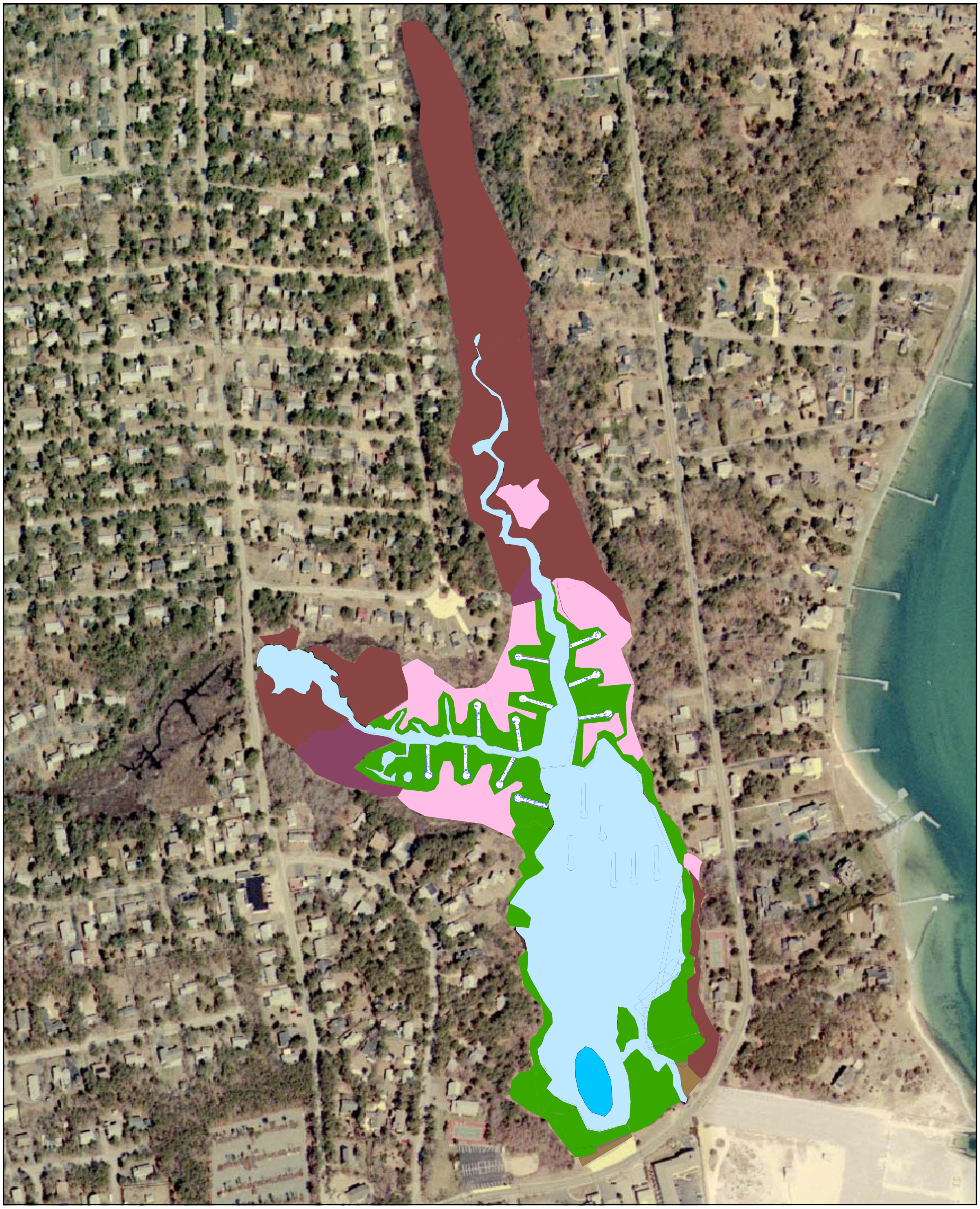


Figure 11



Legend

0 | 405 | 810 | 1,620 | 2,430 Feet

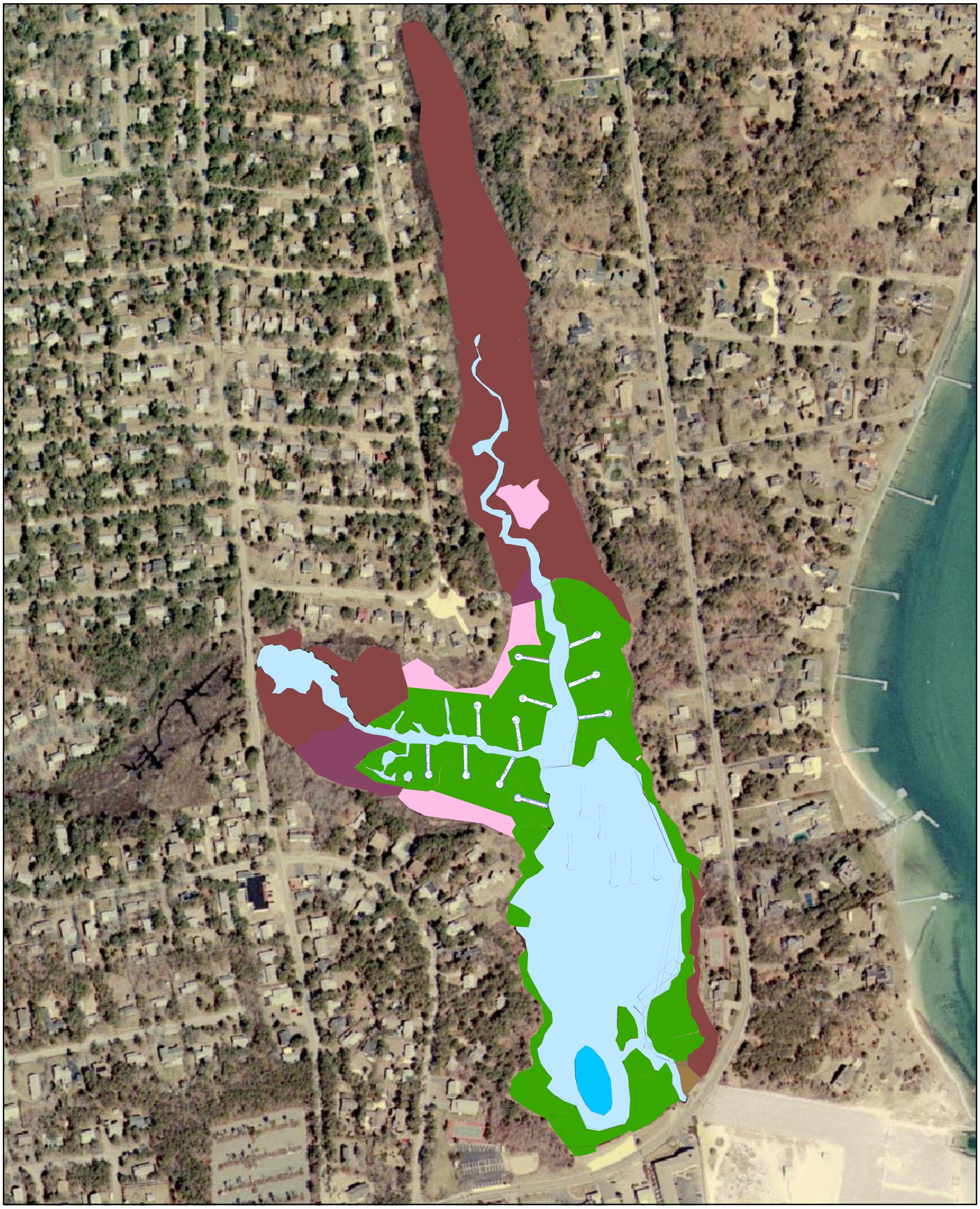
- Phragmites
- Typha
- Typha/Lythrum mix
- disturbed area
- new channel
- open water
- salt marsh
- shrub
- subtidal

Run Pond
Yarmouth, Mass

N W E S

Vegetation Type
Alternative 2
Add 48-inch diameter culvert

Figure 12



Legend

- Phragmites
- Typha
- Typha/Lythrum mix
- disturbed area
- new channel
- open water
- salt marsh
- shrub
- subtidal

Run Pond
Yarmouth, Mass

Vegetation Type
Alternatives 3 and 4

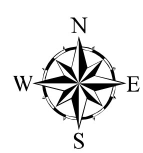


Figure 13

less salt tolerant species such as cattail, *Phragmites*, purple loosestrife, and poison ivy. Increased salinity should also allow *Spartina* to supplant *Myrica gale* and other salt tolerant shrubs in some areas. Improved drainage of the pond should reduce concentrations of sulfide in marsh soils, benefiting the growth of rooted vegetation. Increased salinity and reduced nutrient levels should greatly reduce the growth of filamentous algal mats. Because *Phragmites* is salt tolerant, it is likely that herbicide will be needed to completely eradicate it from the pond. Once eradicated, a long–term monitoring plan is needed to guard against re-colonization in low salinity brackish water areas.

Excavation of the approach channel for Alternatives 2, 3 and 4 would convert some Phragmites and salt marsh to land under water. 0.3 acres of new saltmarsh would be created using dredged material to compensate for this impact.

<u>Aquatic Invertebrates</u>

Conversion of Run Pond from a brackish pond to intertidal habitat would greatly alter the existing aquatic invertebrate community. Currently the benthic community is heavily influenced by floating algal mats. Anoxic conditions that develop under the mats as they decompose suppress the growth of benthic invertebrates such as polychaete worms and soft-shell clams. Conversion of the pond to intertidal habitat should largely eradicate the mats, and improve the productivity of the benthic community. Populations of soft-shell clams, polychaetes worms, and other intertidal invertebrates will increase. Although they are unsightly, degrade water quality, and suppress the benthic community, the algal mats do support a productive invertebrate community composed of midge larvae, aquatic worms (Oligiochaeta), and other invertebrates. This community would be lost with eradication of the mats. Populations of other brackish water invertebrates such as mosquitoes and the seaside drgonlet which require permanent standing water would also likely decrease. Some blue crab would likely be lost during excavation of the expanded approach channel and installation of the new culvert.

<u>Fish</u>

The Run Pond fish community is currently heavily influenced by algal mats. Estuarine fish such as common mummichog cannot exist under mats because of low dissolved oxygen levels and, during the summer and fall, are limited to fringe areas devoid of the mats. Even in the fringes areas, fish are subjected to low oxygen levels while the algal mats decompose. The existing 36” inch culvert provides only limited fish passage from the Bass River to Run Pond.

Alternative 2 would convert the pond to intertidal habitat and largely eradicate the mats. Water throughout the estuary would be well aerated and adequate to support fish. It is assumed that there will be enough permanently flooded pools to maintain the estuarine forage fish community throughout the tidal cycle. Estuarine fish flushed from the system with the outgoing tide, however, would have a low probability of passing through the culverts back into the pond. Some larger predatory estuarine fish will likely occasionally pass through the culverts into the pond with the incoming and outgoing tide. Observations elsewhere suggest that fish will pass through long, dark culverts so long as there is some head space in the culvert (Richard Quinn, USFWS, Personal Communication 2004). Alternatives 3 and 4 would provide similar benefits to the estuarine fish community but much better fish passage.

The restoration of estuary would be expected to enhance the Essential Fish Habitat (EFH) listed species. The estuary will provide a food source and shelter for species that may be used by EFH species for prey. Additional consultation on this project is not needed because this project agrees with the intent of the EFH rule which is to "promote the protection, conservation, and enhancement of EFH." Construction of Alternatives 2, 3, and 4 would have no impact on EFH.

<u>Wildlife</u>

Alternatives 2, 3, and 4 would create approximately 10 acres of intertidal habitat. This area will provide excellent foraging habitat for resident and migratory shorebirds. Currently foraging habitat for shorebirds is limited to summer months when floating algal mats are present. The rest of the time, foraging habitat for shorebirds is absent. The restored estuary will also provide improved foraging habitat for wintering black duck and other waterfowl. Lack of permanent standing water, however, will reduce its value to nesting ducks. Conversion of the pond to estuarine habitat will also reduce its value to tree swallows and bats since production of winged invertebrates (midges, mosquitoes) will decrease. Loss of *Phragmites* will negatively impact some songbird species such as marsh wren which prefer to nest in tall dense emergent vegetation. Habitat for salt marsh specialists such as willet, salt marsh sparrow, and seaside sparrow, however, will be improved.

Construction impacts on wildlife will be minimal since work will occur during the late fall and winter when most wildlife species are absent from the pond. Construction activities, however, will likely deter over wintering black duck from using the southern portion of the pond.

Rare and Protected Species

The proposed project would have no adverse impacts on rare or protected species.

6.5 Historic and Archaeological Resources

No significant cultural resource impacts are expected along the footprint of proposed project alternatives (conduit, open channel) from the boat ramp, parking area to South Street due to previous disturbance from construction of the existing culvert, parking lot, and the road (South Street). However, there are several recorded archaeological sites in similar contexts noted north of the current Project Area. Thus, it is recommended that an archaeological investigation be conducted on any undisturbed areas within the existing wetland fringes on the Run Pond side of South Street prior to final design of the culvert head wall in this area. If any sites are discovered action will be taken to avoid minimize or mitigate any identified resources. These activities will be coordinated with the Massachusetts State Historic Preservation Officer and Wampanoag Tribal Historic Preservation Officer in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and implementing regulations 36 CFR 800.

6.6 Socio-Economic Resources

Recreation

Conversion of Run Pond from open water habitat to an intertidal estuary will have no significant impact on recreation. The pond is currently very rarely used by recreational boaters or fishermen. Dredging of the outlet channel will temporarily impact the recreational blue crab fishery in Run Pond. After construction, blue crab should quickly re-colonize the area. The outlet channel excavated for the project will remain subtidal and should continue to support a small but productive crab fishery. Restoration of the soft-shell clam population may result in development of a recreational clam fishery within the Run Pond Estuary.

Run Pond is close to two hotel/condominium resort complexes and the Bass River Beach is a heavily used town beach. Installation of the culvert will require temporary disruption of the beach parking area. Because work will be done during the off-season, no significant disruption to beach use will occur. During construction, adequate parking spaces will remain to support off-season recreation use of the beach, the town's boat ramp, and the town fishing pier. Alternative 3 would have similar impacts on parking and beach use. Alternative 4 (construction of an open channel), however, would result in the permanent loss of 190 parking spaces. Alternative parking is not available, and the loss of parking would have a significant long-term adverse impact on beach use and the town economy. Because of this, Alternative 4 is not supported by the Town of Yarmouth.

Commercial Fishing

The proposed project will have no impact on commercial shellfish or finfish fisheries. Although the project is expected to enhance soft-shell clam population in the Run Pond Estuary, concern over bacterial contamination will likely preclude establishment of a commercial clam fishery.

Public Health and Safety and Protection of Children

Executive Order 13045 "Protection of Children from Environmental Health risks and Safety risks" seeks to protect children from disproportional environmental health or safety risks. Environmental heath and safety risks include risks attributable to products or substances that a child is likely to come in contact with or ingest. The project construction is located in a public parking area. Temporary risks to the safety of children at the parking lot will be avoided by creating a construction area that is off limits to the general public. The project will have no long-term increased risk to public health.

Environmental Justice

The proposed project would not create a significant adverse impact on minority or low-income population, or any other population in Yarmouth. The area around Run Pond is mapped as an EJ community by the MA EOEA. The proposed project would improve Run Pond water quality and restore the pond to a more natural state – a long-term enhancement of the local environment and community setting.

6.7 Air Quality

Air pollution is defined by the Commonwealth of Massachusetts as the presence in the ambient air space of one or more air contaminates or combinations thereof in such concentrations and of such duration as to: (a) cause a nuisance; (b) be injurious, or be on the basis of current information, potentially injurious to human or animal life, to vegetation, or to property; or (c) unreasonably interfere with the comfortable enjoyment of life and property or the conduct of business. Although equipment operating on the site during construction will emit pollutants including nitrogen oxides, which can lead to the formation of ozone, the project will have essentially no long-term impacts on air quality. As the proposed project site is not a State 21E site, therefore there are no permit requirements for this project. In order to minimize air quality effects during construction, construction activities will comply with the Massachusetts Air Pollution Control regulations pertaining to dust, odor, construction and demolition (310CMR 7.09), noise (310CMR 7.10), and Motor Vehicle Emissions (310CMR 7.11(1)) as well as any applicable local ordinances.

6.8 Hazardous Waste

Sediment testing conducted for this study indicates material to be excavated from Run Pond contains low concentrations of contaminants and will not be classified as a hazardous waste. Material to be excavated from the parking lot will be tested during the next phase of the study ("Design"). Construction Plans will require reuse or disposal of the material pursuant to applicable local, state, and federal requirements.

6.9 Farmland Soils

Due to the lack of prime agricultural soils or other significant farmland soils, and the lack of active agriculture within the project area, there will be no impact to farmland soils as a result of this project.

6.10 Cumulative Impacts

Cumulative impacts are those resulting from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. This section discusses the features of the project relative to the concept of cumulative impacts.

In the past this was a natural system with a open channel between the wetland and the ocean. During the 1990's this area experienced extensive residential and recreational growth and resulted in almost 100 percent development of available land. In the 1950s the open channel was placed in a culvert and the Town parking area and boat ramp created. This is an important current economic resource for the town. The proposed project includes adding a second culvert at the site and will have a beneficial environmental effect on Run Pond and associated wetlands that have been impacted as a result of this past growth. The second culvert is also likely to increase fish utilization of the pond area. Because the project will help restore ecological conditions in Run Pond to a state they had been in the past prior to development and construction in this area, this project will not contribute to any significant cumulative impacts, but will in fact negate some of the cumulative impacts from these past activities. There are no adverse cumulative impacts projected as a result of the project.

7.0 STATEMENT OF FINDINGS

7.1 Conclusions

The Run Pond restoration project in Yarmouth, Massachusetts is an opportunity to restore 30 acres of coastal wetlands habitat.

The recommended project, Alternative 2, is described in detail in Section 5.1 of this report. Incremental and cost effectiveness analysis demonstrates that Alternative 2 is cost effective and a best buy plan and is the National Ecosystem Restoration (NER) plan. The town of Yarmouth, the non-federal project sponsor, supports Alternative 2 as the recommended plan.

7.2 Recommendation

It is recommended that the Run Pond coastal wetland restoration project be approved and implemented. The proposed action is a justifiable expenditure of Federal funds and appropriate for implementation under authority provided by Section 206 of WRDA 1996 (P.L.104-303) as amended.

Run Pond Study Coordination Summary

1. General: This project was coordinated with the following:

Federal Agencies
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
National Marine Fisheries Service
State Agencies – Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection
Division of Fisheries and Wildlife
Massachusetts Historical Commission
Local Agencies
Town of Yarmouth, Department of Natural Resources
Town of Yarmouth, Conservation Commission
Town of Yarmouth. Town Administrator
Native American
Wampanoag Tribe of Gay Head

2. Coordination Activities and Letters: Agencies were invited to a coordinated site visit to discuss the proposed restoration project in May 2000. All appropriate agencies were invited and the following attended:

David Shepardson – Exect. Office of Envir. Affairs/MEPA
Brad Hall – Yarmouth Conservation Commission
Liz Kouloheras – MA DEP, Wetlands and Waterways
Vin Malkoski – MA Div. of Marine Fisheries
Ed Reiner – U.S. Environmental Protection Agency
Rick deMello – Town of Yarmouth Engineer

Follow-up coordination letters were sent during the study to the U.S. Fish and Wildlife Service, National Marine Fisheries Service, Massachusetts Division of Fisheries and Wildlife, and Massachusetts Historical Commission. Response letters from these agencies are included after this summary. In addition, the Corps met with representatives of the Wapanoag Tribe on site to discuss the project and any archaeological investigations that would need to be included before construction. The Corps also has discussed this project with the Massachusetts Office of Coastal Zone Management Office, Wetland Restoration Program.

3. Public Notice and Press Release:

A public notice announcing the availability of the Environmental Assessment (EA) for public review was issued on xxx. The notice was sent to approximately xx parties, including all those known to have an interest in the Run Pond study and general mailing lists maintained by New England District Regulatory Division. A copy of the public notice is provided as an attachment.

A public notice of the proposed project and EA will be issued by the Corps New England District following approval to release EA for public review from New York Division. A 30-day public review period will be provided.

4. Availability of Draft Decision Document and EA

Copies of the draft decision document and EA were sent to the following federal, state, and local government agencies:

List to be added

Copies of the draft Decision Document/ EA will be available for public review at several locations: the Yarmouth Public Library, Yarmouth Town Clerk, and the Town of Yarmouth Conservation Department. Copies of the documents were also available on CD upon request. The entire report was also available on the Corps of Engineers New England District website.

5. FCAR

FCAR (letter) from USFWS provided in attached correspondence.

6. Comments Received

To be added after public notice period.

TOWN OF YARMOUTH

1146 ROUTE 28 SOUTH YARMOUTH MASSACHUSETTS 02664-4492
Telephone (508) 398-2231, Ext. 271, 270 — Fax (508) 398-2365

BOARD OF SELECTMEN

TOWN ADMINISTRATOR
Robert C. Lawton, Jr.

June 30, 2006

Mr. John R. Kennelly
Chief, Planning Branch
US Army Corps of Engineers
New England Division
696 Virginia Road
Concord, Massachusetts 01742-2751

Dear Mr. Kennelly:

The Town of Yarmouth has reviewed the internal draft Wetland Restoration Detailed Project Report and Environmental Assessment dated November 2004. The draft report documents the feasibility of restoring Run Pond a coastal wetland area affected by insufficient tidal flushing.

The report documents the estimated cost of the project, including studies, preparation of plans and specifications, construction, and lands, easements, rights-of-way, relocations, and disposal areas (LERRD).

We understand that the non-Federal sponsor is responsible for 35% of the total project cost and for 100% of any operations and maintenance cost. It is our understanding that we will be credited at fair market value for any LERRD provided by the Town of Yarmouth and that this amount will be applied toward the 35% cost share as appropriate.

The town hereby concurs with the recommendation noted as "Alternative 2" of the draft report and supports the proposed project recommend in the report. The Town also acknowledges our intention to sign the draft Project Cooperation Agreement (PCA) as the non-federal sponsor for the project.

Please direct any questions you may have on this letter to Mr. Karl von Hone, Director of Natural Resources Yarmouth.

Sincerely,

Robert C. Lawton, Jr.
Town Administrator

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

February 4, 2005

Reference: Project — Run Pond Coastal Wetland Restoration Project; Location — Yarmouth, MA

Mr. John R. Kennelly
Chief of Planning
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Dear Mr. Kennelly:

This is in response to your request for a Final Coordination Act Report for the subject proposed coastal wetland restoration project in Yarmouth, Massachusetts. Information on the presence of federally-listed and/or proposed endangered or threatened species in relation to the proposed activity is also provided. Our comments are provided pursuant to Section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531-1543), and the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661-667d).

Endangered Species Comments

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service (Service) are known to occur in the project area. Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required.

This concludes our review of listed species and critical habitat in the project location and environs referenced above. No further Endangered Species Act coordination of this type is necessary for a period of one year from the date of this letter, unless additional information on listed or proposed species becomes available.

Fish and Wildlife Coordination Act Comments

The Corps proposes to restore about 30 acres of coastal wetland through the installation of a 900-foot-long, 48-inch-diameter culvert under the town's existing parking area. The culvert will be used in addition to an existing culvert, and it will include tide gates on both the old and new culvert. In addition, a 0.4 acre depression will be created in the pond. The depression is meant to serve as a fish refuge during low tide. Also proposed is the creation of 0.3 acre of fringe wetlands and eradication of phragmites.

As stated in our letter dated November 5, 2001, the Service supports efforts to restore tidal flushing to the pond in order to restore the functions and values of the pond and the surrounding salt marsh. The Service also stated that an open channel would be preferable over an enclosed culvert, as an open channel would provide additional habitat and increased flushing of the pond. As a result, the Corps added Alternative 4: Box Culvert/Open Channel to the alternatives section of the Draft Environmental Assessment. The Corps concluded that Alternative 4 would eliminate one half of the town's recreational parking spaces. This was not considered a feasible alternative, as removal of the parking area would create an economic hardship for the town.

Although the Service would prefer to see Alternative 4 implemented, we do not object to the Corps' preferred alternative. These comments do not preclude future evaluation and recommendations by the U.S. Fish and Wildlife Service, pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401: 16 U.S.C. 661 et seq.), should project specifics change.

Thank you for your coordination. Please contact us at 603-223-2541 if we can be of further assistance.

Sincerely yours,

William J. Neidermyer

William J. Neidermyer
Assistant Supervisor, Federal Activities
New England Field Office

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO:
ATTENTION OF:

December 3, 2003

RECEIVED
DEC 08 2003
MASS. HIST. COMM
34170

Engineering/Planning Division
Evaluation Branch

CONCURRENCE: Brona Simon
12/22/03
BRONA SIMON
DEPUTY STATE HISTORIC
PRESERVATION OFFICER
MASSACHUSETTS
HISTORICAL COMMISSION

Ms. Cara Metz, State Historic Preservation Officer
Massachusetts Historical Commission
The Massachusetts State Archives Building
220 Morrissey Boulevard
Boston, Massachusetts 02125

Dear Ms. Metz:

The U.S. Army Corps of Engineers, New England District, is preparing an Environmental Assessment for a proposed Section 206 Ecosystem Restoration project at Run Pond in Yarmouth, Massachusetts (see enclosed location map). We would like your formal comments on the following undertaking.

The proposed restoration site is located at the extreme southern end of Run Pond, also known as Crowell Pond, on South Street and directly across from Bass River Beach in the southeastern corner of Yarmouth. Its tidal inlet is to Nantucket Sound, near the mouth of the Bass River. Project components include the existing boat ramp at Bass River Beach proceeding directly west across the beach parking lot crossing South Street to Run Pond.

The Run Pond restoration site is approximately 40 acres in size, with the salt pond itself about nine acres and the surrounding salt marsh of about 31 acres. An 800+ foot long culvert connects the pond to Nantucket Sound. Currently the culvert diameter varies from three to five feet, restricting tidal flow and drainage at the site. This restriction on tidal flows has resulted in a lowering of salinity with *Iva frutescens* and *Phragmites australis* species invading the formerly *Spartina*-dominated salt marsh. Extensive algae blooms occur each summer. Further degradation of the site is expected unless flow conditions are improved.

The purpose of this study is to investigate and identify ways to restore the ecology and health of Run Pond. The major feature of the proposed project would be construction of a new, larger inlet (culvert) to the pond to replace the existing culvert. Historically, a meandering tidal creek fed the area; however, as a result of development between the site and ocean, the creek was routed through a culvert. Project alternatives would consist of the following (please refer to enclosed draft plans):

- one additional 48" supplemental pipe (alignment shown on sheet C-1) running from the Bass River west across the beach parking lot, crossing South Street and ending adjacent to the existing culvert;

- two 5' X 10' supplemental twin box culverts placed south of the existing boat ramp at Bass River Beach and running west across the beach parking lot across South Street culminating adjacent to the existing culvert on Run Pond (sheet C-2); and

- concrete "U" channel alignment (sheet C-3) beginning north of the existing boat ramp and following the northernmost beach parking lot (up to the property line), crossing South Street and culminating north of the existing culvert on Run Pond.

A review of historic and archaeological site files in your office revealed that several prehistoric sites are located outside of the present project area in similar environmental contexts near small ponds. A prehistoric site of unknown temporality is located to the northwest of Seine Pond. Sites known as Seine Pond #1 and #2 are located on the northeast and southeast shores of Seine Pond, respectively. Little additional info is available. Seine Pond #1 appears to have been disturbed by a nearby sand and gravel pit. All three sites are located in Yarmouth and were recorded under the auspices of the Massachusetts Archaeological Society in 1942 (NW of Seine Pond) and 1975 (Seine Pond #1 and #2). An additional prehistoric site dating from the Middle Archaic (7500-5000 years Before Present (BP)) through the Late Woodland Periods (1000-450 BP) is located east of Run Pond on the opposite side of the Bass River along Davis Beach (West Dennis Beach) in Dennis. Cultural material including a variety of projectile points and stone tools has been collected along the beach; however, some appear to have come from dredging piles as a result of beach nourishment operations. This site's integrity is unknown and may have been compromised by construction of a beach causeway. However, there are no known or recorded sites within the proposed Run Pond project area. The Bass River National Register Historic District is located to the north and northeast of the study area.

An assessment of the project alternatives indicates that significant cultural resource impacts are not expected along the footprint of proposed project alternatives (conduit, concrete channel) from the boat ramp, parking area to South Street (due to previous disturbance from construction of the existing culvert), parking lot, and the road (South Street). It is, however, recommended that an archaeological investigation be conducted of construction impacts in any undisturbed areas within the existing wetland fringes on the Run Pond side of South Street during the Plans and Specifications phase. Several recorded archaeological sites in similar contexts are noted north of the current project area. These activities will be coordinated with your office and the Wampanoag Tribal Historic Preservation Officer in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and implementing regulations 36 CFR 800. We would appreciate your concurrence with this determination.

If you have any questions, please contact Mr. Marc Paiva, project archaeologist, at (978) 318-8796.

Sincerely,

Christopher L. Hatfield

for John R. Kennelly
Chief of Planning

Enclosures

Copy furnished (with enclosures):
Ms. Beverly Wright, Chairperson
Wampanoag Tribe of Gay Head (Aquinnah)
20 Black Brook Road
Aquinnah, Massachusetts 02535

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

John R. Kennelly
Deputy Chief, Engineering/Planning Division
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

November 5, 2001

Dear Mr. Kennelly:

This is in response to your letter dated October 3, 2001, requesting our comments on two proposed environmental restoration projects. The following comments are provided in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1543).

The first project is located at Broad Meadows Marsh in Quincy, Massachusetts. The project would involve the restoration of salt marsh through the removal of dredged material disposed on the marsh from the Town River Federal navigation project. The proposed project would look at alternatives to move all or a portion of the dredged material previously placed on the marsh. The dredged material would be removed down to the proper elevation to support salt marsh grasses.

Salt marshes are highly valuable ecosystems which provide feeding and nesting habitat for numerous species of birds and serve as a source of detritus for estuarine detritus-based food webs. Therefore, the U.S. Fish and Wildlife Service (Service) supports efforts to restore salt marsh through the removal of fill or the restoration of tidal flushing. For this project, we recommend, in addition to the removal of the dredged material from the surface of the marsh, that a series of channels in a dendritic pattern be created within the restored marsh. These channels will help achieve tidal flushing of the entire marsh and will create a diversity of habitat types. In addition, we recommend that some small islands just above the high tide line, possibly sections of the dike, remain to add to the habitat diversity. We also recommend that the creation of salt pannes be considered.

The second project is located at Run Pond (Crowell Pond) in Yarmouth, Massachusetts. This project would identify alternatives to restore the ecology and health of the pond and the surrounding salt marsh. A 900-foot long culvert underneath a parking lot connects the pond to Nantucket Sound. The culvert is restricting flow to the pond, resulting in extensive algal blooms each summer and a degradation of the surrounding salt marsh.

The Service would support efforts to restore tidal flushing to the pond in order to restore the functions and values of the pond and the surrounding salt marsh. We believe that the priority should be given to creating an open channel wherever practicable. This channel would provide additional habitat as well as providing for increased flushing of the pond. An open channel is also likely to facilitate fish movement to and from the pond more than an enclosed culvert. The channel should be buffered from the parking lot with a vegetated buffer and all run-off from the parking lot should be contained and treated before it is allowed to enter the channel.

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in either of the project areas, with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required. Should project plans change, or additional information on listed or proposed species becomes available, this determination may be reconsidered.

If you have any questions concerning these comments, please contact Philip Morrison at 603-223-2541.

Sincerely yours,

William J. Neidermyer

William J. Neidermyer
Assistant Supervisor
Federal Activities
New England Field Office

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

OCT 29 2001

Mr. John R. Kennelly
Deputy Chief, Engineering/ Planning Division
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

RE: Broad Meadows Marsh and Run Pond Restoration Projects

Dear Mr. Kennelly:

The National Marine Fisheries Service (NMFS) is pleased to provide this letter of support for both the Broad Meadows and Run Pond salt marsh restoration projects located respectively in the municipalities of Quincy and Yarmouth, Massachusetts. The Quincy project proposes to remove historic dredged material and restore approximately 70 acres of salt marsh and the Yarmouth project is identifying alternatives to restore tidal flow to a nine acre salt pond and surrounding salt marsh.

During the past year our habitat restoration and project review staff have participated in multi-agency site visits and discussions regarding these projects. Based on our preliminary assessment of these projects, we encourage the Army Corps to move forward with more detailed design plans and we do not envision any outstanding issues regarding NMFS trust resources that could interfere with project implementation. Both projects are relatively separated from open ocean waters and do not support any Federally threatened or endangered species under the jurisdiction of our agency.

We look forward to reviewing further detailed plans for these projects and the opportunity to provide additional comments. In the meantime, please feel free to contact Eric Hutchins at (978) 281-9313 if we can be of any assistance as this project moves forward.

Sincerely,

Peter Colosi, Jr.

Peter D. Colosi, Jr.
Assistant Regional Administrator
for Habitat Conservation

cc: Dave Webster, USEPA
Mike Bartlett, USFWS
Christy Foote-Smith, MAWRP

File: MA-Quincy/Yarmouth
Salt Marsh Restoration

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

October 24, 2001

John R. Kennelly
Department of the Army
New England District, Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Re: Crowell Pond
Yarmouth, MA
NHESP File: 01-9569

Dear Mr. Kennelly,

Thank you for contacting the Natural Heritage and Endangered Species Program for information regarding state-protected rare species in the vicinity of the site identified above.

At this time we are not aware of any rare plants or animals or exemplary natural communities in the area of this site.

This review concerns only rare species of plants and animals and ecologically significant natural communities for which the Program maintains site-specific records. This review does not rule out the possibility that more common wildlife or vegetation might be adversely affected if this site is developed, especially if it will modify currently undeveloped areas. Should site plans change, or new rare species information become available, this evaluation may be reconsidered.

Please call me at (508)792-7270 x.154 if you have any questions.

Sincerely,

Christine Vaccaro

Christine Vaccaro
Environmental Review Assistant

Natural Heritage & Endangered Species Program
Route 135, Westborough, MA 01581 **Tel:** (508) 792-7270 x 200 **Fax:** (508) 792-7821
An Agency of the Department of Fisheries, Wildlife & Environmental Law Enforcement
http://www.state.ma.us/dfwele/dfw/nhesp

COMPLIANCE WITH ENVIRONMENTAL FEDERAL STATUTES AND EXECUTIVE ORDERS

Federal Statutes

1. Archaeological Resources Protection Act of 1979, as amended, 16 USC 470 et seq.

Compliance: *Issuance of a permit from the Federal land manager to excavate or remove archaeological resources located on public or Indian lands signifies compliance. Not applicable to this project.*

2. Preservation of Historic and Archeological Data Act of 1974, as amended, 16 U.S.C. 469 et seq.

Compliance: *Project has been coordinated with the State Historic Preservation Officer. No Impacts to archaeological resources anticipated.*

3. American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.

Compliance: *Must ensure access by Native Americans to sacred sites, possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. Not applicable to this project.*

4. Clean Air Act, as amended, 42 U.S.C. 7401 et seq.

Compliance: *Public notice of the availability of this report to the Environmental Protection Agency will provide compliance pursuant to Sections 176c and 309 of the Clean Air Act.*

5. Clean Water Act of 1977 (Federal Water Pollution Control Act Amendments of 1972) 33 U.S.C. 1251 et seq.

Compliance: *Section 404(b)(1) Evaluation and Compliance Review is incorporated into the project report. An application shall be filed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.*

6. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq.

Compliance: *A CZM consistency determination will be provided to the State for review and concurrence that the proposed project is consistent with the approved State CZM program.*

7. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.

Compliance: *Coordinated project with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). No issues were identified pursuant to Section 7 of the Endangered Species Act.*

8. Estuarine Areas Act, 16 U.S.C. 1221 et seq.

Compliance: *Not applicable report is not being submitted to Congr*ess

9. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.

Compliance: *Public notice of availability to the project report to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.*

10. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.

Compliance: *Project coordinated with the USFWS, NMFS, and state fish and wildlife agencies and completes compliance with the Fish and Wildlife Coordination Act.*

11. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.

Compliance: *Public notice of the availability of this report to the National Park Service (NPS) and the Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.*

12. Marine Protection, Research, and Sanctuaries Act of 1971, as amended, 33 U.S.C. 1401 et seq.

Compliance: *Applicable if the project involves the transportation or disposal of dredged material in ocean waters pursuant to Sections 102 and 103 of the Act, respectively. Not applicable. Disposal of dredge material in ocean waters will not occur.*

13. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.

Compliance: *Coordination with the State Historic Preservation Office signifies compliance.*

14. Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3000-3013, 18 U.S.C. 1170

Compliance: *Regulations implementing NAGPRA will be followed if discovery of human remains and/or funerary items occur during implementation of this project. Not applicable to this project.*

15. National Environmental Policy Act of 1969, as amended, 42 U.S.C 4321 <u>et seq</u>.

Compliance: *Preparation of an Environmental Assessment signifies partial compliance with NEPA. Full compliance shall be noted at the time the Finding of No Significant Impact or Record of Decision is issued.*

16. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 <u>et seq</u>.

Compliance: *No requirements for projects or programs authorized by Congress. The proposed aquatic ecosystem restoration project is being conducted pursuant to the Congressionally-approved authority.*

17. Watershed Protection and Flood Prevention Act as amended, 16 U.S.C 1001 <u>et</u> <u>seq</u>.

Compliance: *Floodplain impacts must be considered in project planning. No floodplain impacts will occur.*

18. Wild and Scenic Rivers Act, as amended, 16 U.S.C 1271 <u>et</u> <u>seq</u>.

Compliance: *No designated Wild and Scenic Rivers in project area.*

19. Magnuson-Stevens Act, as amended, 16 U.S.C. 1801 <u>et seq</u>.

Compliance: *Coordination with the National Marine Fisheries Service and preparation of an Essential Fish Habitat (EFH) Assessment signifies compliance with the EFH provisions of the Magnuson-Stevens Act.*

<u>Executive Orders</u>

1. Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971

Compliance: *Coordination with the State Historic Preservation Officer signifies compliance.*

2. Executive Order 11988, Floodplain Management, 24 May 1977 amended by Executive Order 12148, 20 July 1979.

Compliance: *Public notice of the availability of this report fulfills the requirements of Executive Order 11988, Section 2(a) (2).*

3. Executive Order 11990, Protection of Wetlands, 24 May 1977.

Compliance: *Public notice of the availability if this report for public review fulfills the requirements of Executive Order 11990, Section 2 (b).*

4. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 Jan. 1979.

Compliance*: Not applicable. Project located within the United States.*

5. Executive Order 12898, Environmental Justice, 11 February 1994.

Compliance: *Not applicable, the project is not expected to have a significant impact on minority or low income population, or any other population in the United States.*

6. Executive 13007, Accommodation of Sacred Sites, 24 May 1996

Compliance: *Not applicable unless on Federal lands, then agencies must accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, and avoid adversely affecting the physical integrity of such sacred sites.*

7. Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks. 21 April, 1997.

Compliance: *Not applicable, the project would not create a disproportionate environmental health or safety risk for children.*

8. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000.

Compliance: Consulted with Indian Tribal Governments regarding project.

Executive Memorandum

Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980.

Compliance: *Not applicable project does not involve or impact agricultural lands.*

White House Memorandum, Government-to-Government Relations with Indian Tribes, 29 April 1994.

Compliance: *Consultation with the Federally Recognized Indian Tribe signifies compliance.*

NEW ENGLAND DISTRICT
US ARMY CORPS OF ENGINEERS, CONCORD, MA
CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

PROJECT: Run Pond Coastal Wetland Restoration Project.
Nantucket Sound, Yarmouth, MA

PROJECT MANAGER: Barbara Blumeris

FORM COMPLETED BY: Mike Penko

DESCRIPTION:

The restoration site is located in the Town of Yarmouth, Massachusetts, in Barnstable County. The 30 acre pond is connected to the Bass River by a 900 ft-long culvert. The culvert restricts the tidal flow and flushing at the site. The pond experiences extensive algae blooms and low dissolved oxygen levels each summer. Invasive plants, purple loosestrife and Phragmites, invading the formerly Spartina-dominated salt marsh.

The proposed project involves installation of a 48-inch diameter culvert to increase tidal exchange. The existing culvert is to remain. The new culvert would extend from a new headwall north of South Shore Drive through the town public parking area to the outlet at Bass River. The culvert invert at South Shore Road would be set at El. -1.0 ft. NGVD or about 1 foot lower than the exiting culvert invert. The existing channel upstream of the headwall would be excavated to El. –1.0 NGVD and widened to a 50-foot width for a distance of 100 feet upstream of the headwall. About 700 cubic yards material would be excavated from the channel area. The invert elevations of both culverts at the outlet headwall would be set at El. –2.39 NGVD. The alternative includes construction of a shallow depression near Shore Drive (0.4 acres) at the southern end of the pond. The depression would provide a refuge for fish and other aquatic life during low tide when much of the pond bottom will be exposed. About 0.3 acres of vegetated salt marsh would be constructed at the southern end of the pond using material excavated from the depression. The constructed saltmarsh would compensate for vegetated wetland excavated to create the approach channel to the new culverts. The plan also includes excavation of eleven 6 foot wide ditches within vegetated wetlands to improve tidal exchange and promote growth of salt marsh vegetation.

NEW ENGLAND DISTRICT
U.S. ARMY CORPS OF ENGINEERS, CONCORD, MA
EVALUATION OF SECTION 404(b)(1) GUIDELINES

PROJECT: Run Pond Coastal Wetland Restoration Project

1. Review of Compliance (Section 230.10(a)-(d)).

a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose;

YES	NO
X	

b. The activity does not appear to: 1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of Federally listed threatened and endangered species or their critical habitat; and 3) violate requirements of any Federally designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies);

YES	NO
X	

c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (if no, see section 2);

YES	NO
X	

d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see section 5).

YES	NO
X	

2. <u>Technical Evaluation Factors (Subparts C-F).</u>

	N/A	Not Significant	Significant
a. Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C).			
1) Substrate		X	
2) Suspended particulates/turbidity		X	
3) Water		X	
4) Current patterns and water circulation			X
5) Normal water fluctuations			X
6) Salinity gradients			X
b. Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D).			
1) Threatened/ endangered species		X	
2) Fish, crustaceans, mollusks and other aquatic organisms in the food web			X
3) Other wildlife			X
c. Potential Impacts on Special Aquatic Sites (Subpart E).			
1) Sanctuaries and refuges	X		
2) Wetlands			X
3) Mud flats			X
4) Vegetated shallows			X
5) Coral reefs	X		
6) Riffle and pool complexes	X		
d. Potential Effects on Human Use Characteristics (Subpart F).			
1) Municipal and private water supplies		X	
2) Recreational and commercial fisheries		X	
3) Water-related recreation		X	
4) Aesthetics			X
5) Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves	X		

3. Evaluation and Testing (Subpart G).

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

1) Physical characteristics.........................__X___
2) Hydrography in relation to known or anticipated sources of contaminants.....................__X___
3) Results from previous testing of the material or similar material in the vicinity of the project... __X__
4) Known, significant sources of persistent pesticides from land runoff or percolation....................................... ______
5) Spill records for petroleum products or designated hazardous substances (Section 311 of CWA)......______
6) Public records of significant introduction of contaminants from industries, municipalities, or other sources.....................................______
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities..______
8) Other sources (specify)..........................______

Note all impacts marked above as significant are habitat improvements (i.e. positive significant impacts).

List appropriate references: See Run Pond DPR/EA.

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to require constraints. The material meets the testing exclusion criteria.

X_____ ______

YES NO

4. <u>Disposal Site Delineation (Section 230.11(f)).</u>

a. The following factors, as appropriate, have been considered in evaluating the disposal site.

1) Depth of water at disposal site.................X____
2) Current velocity, direction, and variability at disposal site....................X____
3) Degree of turbulence...............................X____
4) Water column stratification......................X____
5) Discharge vessel speed and direction...______
6) Rate of discharge...................................______
7) Dredged material characteristics (constituents, amount, and type of material, settling velocities)...............X___
8) Number of discharges per unit of time..._____
9) Other factors affecting rates and patterns of mixing (specify)...................____

<u>List appropriate references</u>. See Run Pond DPR/EA

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable.

X	______
YES	NO

5. <u>Actions To Minimize Adverse Effects (Subpart H).</u>

All appropriate and practicable steps have been taken, through application of recommendation of Section 230.70-230.77 to ensure minimal adverse effects of the proposed discharge.

X	______
YES	NO

6. Factual Determination (Section 230.11).

A review of appropriate information as identified in items 2 - 5 above indicates that there is minimal potential for adverse short or long term environmental effects of the proposed discharge as related to:

	YES	NO
a. Physical substrate (review sections 2a, 3, 4, and 5 above).	X	
b. Water circulation, fluctuation and salinity (review sections 2a, 3, 4, and 5).	X	
c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5).	X	
d. Contaminant availability (review sections 2a, 3, and 4).	X	
e. Aquatic ecosystem structure, function and organisms(review sections 2b and c, 3, and 5)	X	
f. Proposed disposal site (review sections 2, 4, and 5).	X	
g. Cumulative effects on the aquatic ecosystem.	X	
h. Secondary effects on the aquatic ecosystem.	X	

7. Findings of Compliance or Noncompliance.

a. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines and represents the least environmentally damaging practical alternative.

X	______
YES	NO

____
Date

____
Philip T. Feir
Colonel, Corps of Engineers
District Engineer

RECORD OF NON-APPLICABILITY (RONA)

Emissions Calculations for:

Run Pond, Coastal Wetland Restoration
Yarmouth, Massachusetts

GENERAL CONFORMITY - RECORD OF NON-APPLICABILITY

Project/Action Name:	*Run Pond, Coastal Wetland Restoration Project, Yarmouth, Massachusetts*
Project/Action Point of Contact:	*Michael Penko phone: 978-318-8139*

General Conformity under the Clean Air Act, Section 176 has been evaluated for the subject project according to the requirements of 40 CFR 93, Subpart B. The requirements of this rule are not applicable to this project/action because:

Total direct and indirect emission from this project/action are estimated at less than 100 tons for Ozone, and are below the conformity threshold value established at 40 CFR 93.153(b) of 100 tons/year of Ozone;

AND

The project/action is not considered regionally significant under 40 CFR 93.153(i).

Supporting documentation and emissions estimates are:

(X) ATTACHED
(X) APPEAR IN THE NEPA DOCUMENTATION
( ) OTHER

SIGNED____
Jay Mackay, Chief Environmental Resources Section

General

Ambient air quality is protected by Federal and state regulations. The U.S. Environmental Protection Agency (EPA) has developed National Ambient Air Quality Standards (NAAQS) for certain air pollutants, with the NAAQS setting concentration limits that determine the attainment status for each criteria pollutant. The six criteria air pollutants are ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead.

Yarmouth and the entire State of Massachusetts is designated as a non-attainment area for ozone. Effective June 15, 2004, all of Eastern Massachusetts was designated by the EPA as moderate non-attainment areas for the 8-hour ozone standard.

U.S. Army Corps of Engineers guidance on air quality compliance is summarized in Appendix C of the Corps Planning Guidance Notebook (ER1105-2-100, Appendix C, Section C-7, pg. C-47). Section 176 (c) of the Clean Air Act (CAA) requires that Federal agencies assure that their activities are in conformance with Federally-approved CAA state implementation plans for geographic areas designated as non-attainment and maintenance areas under the CAA. The EPA General Conformity Rule to implement Section 176 (c) is found at 40 CFR Part 93.

Clean Air Act compliance, specifically with USEPA's General Conformity Rule, requires that all Federal agencies, including Department of the Army, to review new actions and decide whether the actions would worsen an existing National Ambient Air Quality Standards (NAAQS) violation, cause a new NAAQS violation, delay the State Implementation Plan (SIP) attainment schedule of the NAAQS, or otherwise contradict the State's SIP.

The Commonwealth of Massachusetts is authorized by the USEPA to administer its own air emissions permit program, which is shaped by its SIP. The SIP sets the basic strategies for implementation, maintenance, and enforcement of the NAAQS. The SIP is the federally enforceable plan that identifies how that state will attain and/or maintain the primary and secondary NAAQS established by the USEPA. In Massachusetts, Federal actions must conform to the Massachusetts state implementation plan or Federal implementation plan. The Corps must evaluate and determine if the proposed action (construction and operation) will generate air pollution emissions that aggravate a non-attainment problem or jeopardize the maintenance status of the area for ozone. When the total direct and indirect emissions caused by the operation of the Federal action/facility are less than threshold levels established in the rule (40 C.F.R. § 93.153), a Record of Non-applicability (RONA) is prepared and signed by the facility environmental coordinator.

Air Quality Analysis for the Proposed Run Pond Project

Construction window for this project is over a total period of about 9 months, with construction work being done in about 90 working days. Construction activity at the proposed project site would require excavators, dump trucks, pickup-trucks, front-end loaders, a crane, a pile driver, and other construction equipment.

During construction, equipment operating at Yarmouth will emit pollutants that contribute to increased levels of criteria pollutants such as carbon monoxide, nitrogen oxides, and ozone. The emissions for construction vehicles and related equipment will have an insignificant impact to local air quality.

Construction of the proposed project could cause a temporary reduction in local ambient air quality because of fugitive dust and emissions generated by construction equipment. The extent of dust generated would depend on the level of construction activity and dryness. Proper dust suppression techniques would be employed to avoid creating a nuisance for nearby residents during dry and windy weather.

In order to minimize air quality effects during construction, all construction operations would comply with applicable provisions of the Commonwealth of Massachusetts air quality control regulations pertaining to dust, odors, construction, noise, and motor vehicle emissions. No direct or indirect increases or other changes in local or regional air quality are likely to occur with the construction and operation of the proposed project.

The general conformity rule was designed to ensure that Federal actions do not impede local efforts to control air pollution. It is called a conformity rule because Federal agencies are required to demonstrate that their actions "conform with" (i.e., do not undermine) the approved SIP for their geographic area. Federal agencies make this demonstration by performing a conformity review. The conformity review is the process used to evaluate and document project-related air pollutant emissions, local air quality impacts and the potential need for emission mitigation. A conformity review must be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. Non-attainment areas are geographic regions where the air quality fails to meet the NAAQS.

The project is located in Barnstable County, Massachusetts. Barnstable County is considered to be non-attainment for ozone, receiving a “moderate” classification under the new 8-hour ozone air quality classification. The General Conformity thresholds for ozone in a moderate non-attainment area have an emission rate threshold of 50 tons per year (tons/year) of VOC (volatile organic compounds) and 100 tons/year of NO_x (nitrogen oxides) (40 CFR 51.853, 7-1-03).

To conduct a general conformity review and emission inventory for the proposed project, a list of construction equipment was identified. The New England District prepared calculations of the worst-case project specific emissions of NOx and VOCs to determine whether project emissions would be under the General Conformity Trigger Levels (see Attachment).

Because of the small scale of the project, several simplifying assumptions were applied in performing the calculations to prepare a worst-case analysis. The actual emissions would most likely be much lower, but in no case above the calculated values. For instance, the load factor is the average percentage of rated horsepower used during a source's operational profile. To simplify the calculations, we used a worst-case estimate of 1.0, or 100 percent, for all equipment. We used 10 hours per day as worst-case hours of operation for most equipment. We used the total construction duration estimate of 90 working days that is about 2 times the estimated maximum duration for any piece of equipment use. Based on these calculations, the worst-case NOx emissions was 22.77 tons and the worst-case VOC emissions was 3.22 tons. In both cases, the total construction emissions were below the General Conformity Trigger Levels.

The determination of whether or not a project is regionally significant is if its emissions exceed 10% of the state's total emissions budget for the criteria pollutants (40 CFR 93.153 (i)). Table IV – 1 of the 2002 Eastern Massachusetts Supplement to the July 1998 Ozone Attainment State Implementation Plan Submittal (prepared by Massachusetts Department of Environmental Protection, Boston, MA.) lists the total emissions inventories for emissions sources in the state for various years, and predicts estimated inventories for 2007. As noted, the emissions for the Run Pond project are estimated to be 3.23 and 22.77 tons *per year* for both VOCs and NOx respectively. These inventories are calculated as tons per summer day (tpsd) and show that for mobile sources alone, total values of 117.1 tpsd of VOCs and 243.3 tpsd of NOx are predicted for 2007. These values show that *in less than one day*, mobile sources alone within the area of Eastern Massachusetts would exceed the total estimated emissions for both VOCs and NOx for the Run Pond habitat restoration project. Therefore the estimated emissions for the proposed project are below 10% of the total emissions inventory for the Commonwealth of Massachusetts. The activity does not reach the threshold levels established by the USEPA rule, and is not regionally significant, and therefore the conformity rule is inapplicable here.

General Conformity Review and Emission Inventory for the Run Pond Coastal Wetland Restoration Project, Yarmouth, Massachusetts

	Project Emission Sources and Estimated Power						NOx Emission Estimates		VOC Emission Estimates	
							NOx	NOx	VOC	VOC
	# of			Estimated	Worst Case		EF	Emissions	EF	Emissions
Equipment/Engine Cate	Engines	hp	LF	hrs of operation	hrs of operation	hp-hr	(g/hp-hr)	(tons)	(g/hp-hr)	(tons)
AIR COMPRESSOR	1	115	1.00	134	900	103,500	9.200	1.05	1.300	0.15
PAVING BREAKER	1	20	1.00	251	900	18,000	9.200	0.18	1.300	0.03
ASPHALT PAVER	1	150	1.00	13	900	135,000	9.200	1.37	1.300	0.19
ROLLER	1	140	1.00	72	900	126,000	9.200	1.28	1.300	0.18
CRANE	1	350	1.00	458	900	315,000	9.200	3.19	1.300	0.45
DRAGLINE/CLAMSHE	1	450	1.00	360	900	405,000	9.200	4.11	1.300	0.58
HYD EXCV, CRAWLEF	1	340	1.00	225	900	306,000	9.200	3.10	1.300	0.44
LOADER	1	150	1.00	114	900	135,000	9.200	1.37	1.300	0.19
PILE HAMMER	1	200	1.00	967	900	180,000	9.200	1.83	1.300	0.26
DUMP TRUCK	1	330	1.00	360	900	297,000	9.200	3.01	1.300	0.43
HWY TRUCK	1	250	1.00	56	900	225,000	9.200	2.28	1.300	0.32
Total Emissions							**NOx Total**	**22.77**	**VOC Total**	**3.22**

NOTES:

Horsepower Hours

hp-hr = # of engines*hp*LF*hrs of operation

Worst Case Hours of Operation

Assume 90 working days for piece of equipment and 10 hour days

Load Factors

Load Factor (LF) represents the average percentage of rated horsepower used during a source's operational profile. For this worst case estimate, LF is held at 1 for all equipment. Typical is 0.4 to 0.6

Emission Factors

NOx Emissions Factor for Off-Road Construction Equipment is 9.20 g/hp-hr

VOC Emissions Factor for Off-Road Construction Equipment is 1.30 g/hp-hr

Emissions (g) = Power Demand (hp-hr) * Emission Factor (g/hp-hr)

Emissions (tons) = Emissions (g) * (1 ton/907200 g)

8. REFERENCES

Bertness, M.D., P.J. Ewanchuk, and B.R. Silliman. 2002. Anthropogenic modification of New England salt marsh landscapes. *PNAS February 5, 2002.| vol. 99. no. 3 .1395-1398*

Chambers, R.M., L.A. Myerson, and K. Saltonstall, 1999. Expansion of *Phragmites australis* into tidal wetlands of North America. *Aquatic Botany. 64: 261-271.*

MacDonald, D.D., C.G. Ingersoll, T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch. Environ. Contam. Toxicol.* 39: 20-31

K. Saltonstall (2003) Microsatellite variation within and among North American lineages of *Phragmites australis. Molecular Ecology 12 (7) , 1689–1702*

APPENDIX A. HYDROLOGY AND HYDRAULIC ANALYSIS

Appendix A

Hydrologic and Hydraulic Analysis for
Wetlands Restoration Investigation
Run Pond Salt Pond and Salt Marsh
Yarmouth, Massachusetts

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LIST OF PLATES
(Plates provided at end of Appendix)

1. INTRODUCTION

This hydrologic and hydraulic analysis was conducted to provide an assessment of tidal conditions within the Run Pond (also known as Crowell Pond) salt marsh and to determine the culvert size needed to improve tidal flow conditions in the marsh. This work effort includes development of a one-dimensional model of tidal flow. The existing culvert restricts the natural tidal flow and flushing of the marsh. This study was conducted by the New England District, Corps of Engineers for the town of Yarmouth, Massachusetts under the Corps Section 206, Aquatic Ecosystem Restoration Program.

2. BACKGROUND

a. Watershed, Salt Pond, and Salt Marsh Description. The Run Pond salt marsh watershed has a drainage area of approximately 0.27 square miles or 174 acres. The primary stream for the marsh is an unnamed brook, which originates at Willow Street in Yarmouth. The brook flows in a southerly direction, through a small vegetated channel. The salt marsh is bounded by Willow Street on the north, South Street on the east, South Shore Drive on the south, and Run Pond Road on the west. There are low spots in all of the roads surrounding the salt marsh. South Street has a minimum elevation of 5.3 ft NGVD, Run Pond Road has a low elevation of 4.8 ft NGVD, and South Shore Drive has a minimum elevation of 5.7 ft NGVD. Refer to Plate 1 and Plate 2 for the location of the study area.

Land use in the watershed is tidal marsh and residential. Homes surround the majority of the salt pond. With a few exceptions, the first floor elevations of the residences located around the pond are higher than 6.0 ft NGVD. A house located at 6 Crescent Court is a split-level residence and the elevation of the lower level of the house could not be determined in the field. The elevation of the top of the front door threshold is 9.94 ft NGVD therefore, the elevation of the lower level is estimated to be approximately 4 ft NGVD. A house located at 108 Breezy Point Road has a first floor elevation of 11.35 ft NGVD, however it also has a doorway entrance to the basement at elevation of 4.74 ft NGVD. It is not known whether the basement of this residence is finished. A garage located near 189 South Street is at elevation 5.55 ft NGVD.

Run Pond enters a 36-inch High Density Polyethylene (HDPE) pipe on the north side of South Shore Drive (Sta 9+00). The pipe, which is approximately 620 ft long, passes under the Town's parking lot. The 36-inch HDPE pipe connects to an approximately 275 ft long 48-inch Reinforced Concrete Pipe (RCP). The 48-inch pipe drains into the Nantucket Sound, immediately west of the mouth of the Bass River (Sta 0+30). The invert of the culvert, at South Shore Drive in the marsh is -0.14 ft NGVD, and the invert of the culvert that empties into the sound is -2.4 ft NGVD. The pipes are in good operating condition. Table A-1 shows the approximate area-capacity relationship for the Run Pond salt marsh area.

Table A-1. Approximate Area-Capacity for Run Pond

Elevation (ft, NGVD)	Area (acres)	Cumulative Volume (acre-ft)
-1.0	0	0
0.0	0.8	0.3
1.0	6.2	5.8
2.0	9.5	15.4
4.0	38.8	70.6

Note: Area and volume relationships were developed from Town of Yarmouth, MA contour maps completed in 1994.

b. Description of the Problem. Natural tidal flushing of the salt pond and marsh is restricted by the 895 feet long culvert. The culvert restricts the water level fluctuation in the marsh to less than half a foot under spring tide conditions, when the open water tide fluctuates approximately 4 feet. The pond experiences extensive algae blooms in the summer. The salt marsh signs of degradation including lowering of salinity with *Lythrum salicaria* (purple loosestrife) and *Phragmites australis (common reed)* species invading the formerly *Spartina*-dominated salt marsh. If nothing is done to improve flow conditions at the site, it is expected that the area will continue to degrade.

Historically a meandering tidal creek fed the Run pond marsh. However, as a result of development between the site and ocean, the creek was routed through a culvert. By restricting the tidal prism, changes have taken place, which affect the flora and fauna within the marsh.

3. SITE HYDROLOGY

a. Tidal Regime. In the study area, tides are semidiurnal, with two high and two low waters occurring during each lunar day (approximately 24 hours and 50 minutes). The resulting tide range is constantly varying, in response to relative positions of the earth, moon, and sun, with the moon having the primary tide producing effect. Maximum tide ranges occur when orbital cycles of these bodies are in phase. A complete sequence of tide ranges is approximately repeated over an interval of 19 years, known as a tidal epoch. Although exact tidal characteristics are not available at the site, tidal profiles, developed by the Corps, were used to estimate tidal flood frequencies at Yarmouth. See Plate 3 and Plate 4. A summary of estimated tidal datums at the subject site is shown in Table A-2.

b. Freshwater Runoff. Preliminary calculations of expected peak freshwater runoff rates and volumes into the marsh were performed using multiple methods. Peak runoff rates were estimated using the "rational equation" and 1-hour rainfall totals from the Weather Bureau's Technical Publication 40. It is recognized that the size of this drainage area, 0.27 mi^2, is at the upper limit of the applicability for this method. It is also noted that due to the sandy nature of this Cape Cod drainage area, high infiltration losses are likely experienced. A runoff coefficient, "c", of 0.22 was utilized to account for the flat, sandy, residential nature of the drainage area. The results of this analysis are presented in Table A-3.

In an effort to verify the runoff rates predicted by the rational method, three gaged rivers located near the study area were investigated. Unfortunately, there were problems associated with all three of the gages. The Herring River, which is located approximately 3 miles from in the study area in North Harwich, MA was analyzed. The Herring River has a drainage area 9.4 mi^2, considerably larger than the study area. The USGS categorizes the records of this gage as poor and they also point out that flow into the river is regulated by many upstream ponds, some with no outlets. The Quashnet River, which is located approximately 16 miles west of the study area at Waquoit Village, MA and has a drainage area of 2.58 mi^2 was also investigated. There are only 9 years of data for this gage. The Furnace Brook was also investigated. This gage is located in a coastal river basin, however it is a considerable distance from the study area. Located near Marshfield, MA, the Furnace Brook is approximately 45 miles northwest of the study area. The brook has a drainage area of 1.56 mi^2 and a good period of record. Using drainage area ratios raised to the 0.7 power, fresh water flows into Run Pond were estimated using each of the three gages for the purpose of comparison to the rational equation results. The results of these analyses are presented in Table A-4. It is acknowledged that there is a limited degree of confidence associated with these analyses.

The USGS method for estimating the magnitude and frequency of floods in small streams in Massachusetts was also used to estimate the freshwater flows entering Run Pond. It is recognized that due to the location of the study area and the high infiltration rates associated with drainage areas on Cape Cod, this method is not recommended and will likely over estimate the potential flowrates entering the pond. The USGS method for estimating floods in small streams in Rhode Island was also utilized due to the close proximity of the study area to Rhode Island. The MA method is applicable for drainage areas as small as 0.25 mi^2 and as large as 260 mi^2, while the RI method is applicable for drainage areas smaller than 10 mi^2. The results of these analyses are presented in Table A-5.

After considering all the data, the freshwater flows determined using the rational method, presented in Table A-3, were utilized for this study. Based on the other analyses performed, it is likely that the flows estimated using the rational method are conservative. Coincident high tides and significant runoff from rainfall events were considered, since high tides occur twice daily, increasing the probability of simultaneous tidal and interior flooding. This analysis assumes that the total runoff flow enters the pond at the upper end of the salt marsh, at Willow Street.

Table A-2. Estimated Tidal Datum Planes at Yarmouth, MA

Event	Tide Level (ft, NGVD)
100-year Frequency Flood Event	10.0
50-year Frequency Flood Event	8.4
10-year Frequency Flood Event	5.4
1-year Frequency Flood Event	3.8
Maximum Predicted Astronomical High Water	2.1
Mean High Water Spring (MHWS)	2.0
Mean High Water (MHW)	1.7
Mean Tide Level (MTL)	0.5
National Geodetic Vertical Datum (NGVD)	0.0
Mean Low Water (MLW)	-1.1
Minimum Predicted Astronomical Low Water	-1.8

Table A-3. Freshwater Runoff Determined Using "Rational" Method, Run Pond, Yarmouth, MA (Total Drainage Area = 174 acres)

Return Frequency (years)	Discharge (cfs)	Volume (acre-ft)
1	35	13
5	56	21
10	73	28
50	92	35
100	103	39

Table A-4. Freshwater Runoff Determined Using Drainage Area Ratios, Run Pond, Yarmouth, MA (Total Drainage Area = 174 acres)

Return Frequency (years)	Run Pond Discharge based on Herring River analysis (DA = 6016 acres) (cfs)	Run Pond Discharge Based on Quashnet River analysis (DA = 1651 acres) (cfs)	Run Pond Discharge based on Furnace Brook analysis (DA = 998) (cfs)
1	1.0	3.5	0.9
5	3.9	8.2	17.9
10	4.7	8.6	21.9
50	6.5	9.1	30.7
100	7.2	9.2	34.3

Table A-5. Freshwater Runoff Determined Using USGS Methods for Massachusetts and Rhode Island, Run Pond, Yarmouth, MA (Total Drainage Area = 174 acres)

Return Frequency (years)	Run Pond Discharge based on USGS MA method (cfs)	Run Pond Discharge based on USGS RI method (cfs)
2	15	14
5	23	-
10	30	26
50	51	39
100	62	53

4. METHODOLOGY

a. <u>Data Collection.</u> Bathymetric, topographic and tidal monitoring data were collected to describe the existing salt marsh tidal regime and to obtain information to calibrate a model of one-dimensional tidal flow for the Run Pond area. In addition, water quality data was collected to evaluate the source of algae growth in the pond. Limited survey of the area was completed during May 2000 to provide adequate information on the existing culvert size and inverts, the pond's bathymetry, the elevation of vegetation in and around the pond and the elevations of homes surrounding the pond. This was necessary since the only mapping that was available was topographic mapping done by the town in 1994 that was based on aerial photos taken in 1989 and the Dennis, MA U.S. Geological Survey quadrangle, which has a 10-ft contour interval.

As part of the May 2000 survey effort, six cross-sections were obtained throughout the salt marsh. Five spot elevations were collected in the marsh and adjacent uplands. Information on culvert type, length, and invert was also collected. First floor elevations were determined for eight homes located in low-lying areas around the marsh.

A computer generated line data inspection report and video was conducted of the existing 48-inch pipe on November 15, 2001. This inspection identified very few problems inside the drain line other than a limited number of joint separations. The drain line appears to be in good operating condition and no visual observation of a pending internal drain failure.

Using the collected survey data, the salt marsh was broken into three reaches. Referring to Plate 2, Reach 1 comprises the northern portion of the salt marsh, extending from Willow Street to the northern point of Run Pond. Reach 2 comprises the western portion of the salt marsh, extending from Run Pond Road to the northern point of Run

Pond. Reach 3 comprises the southern portion of the salt pond and extends from the northern point of Run Pond downstream to the culvert discharge at the confluence of the Bass River with the Nantucket Sound.

For tidal monitoring purposes, three staff gages were installed (two within the marsh and one in Nantucket Sound) and tied to the National Geodetic Vertical Datum (NGVD) to enable tidal movement to be monitored within the marsh area. One gage was mounted just south of the town boat ramp, near the outlet to the Bass River to provide water levels for the ocean (Gage 1). For interior marsh measurements, one gage was mounted just upstream from the 36 inch culvert at South Shore Drive (Gage 2) and one gage was mounted at the end of a side ditch near Run Pond Road (Gage 3). The locations of these gages are shown on Plate 2. The inverts of all the gages were extended to approximate ocean mean low water to monitor ebb tide conditions.

Tide data was collected for one partial tide cycle on 4 May 2000. The intent of data collection was to document the movement of the tidal prism into the marsh. This data was then used to develop a mathematical model to predict interior tidal conditions for various culvert sizes. For the day studied, the data showed that the existing culvert provides a significant reduction to the tidal regime that exists in Nantucket Sound. The tide elevations in the sound varied from a low tide elevation of -2.24 ft NGVD to a high tide elevation of 2.01 ft NGVD. The elevations within the marsh remained nearly constant. At Gage 2, the water surface elevations within the marsh varied from a low elevation of 1.45 ft NGVD to a maximum elevation of 1.61 ft NGVD. While at Gage 3, the water surface elevations within the marsh only varied from a minimum water surface elevation of 1.56 ft NGVD to a high water level of 1.71 ft NGVD. Plate 5 shows the results of the tidal measurements throughout the salt marsh.

b. <u>Water Quality Sampling</u>. Water quality data was collected on the 18 July, 2001 and the 8 August 2001. The intent of the data collection was to evaluate the water quality of Run Pond to better define the source of algae growth. Samples were collected at five stations at and around Run Pond, see Plate 2. Station S-1 is located at the culvert exit at the Bass River. Stations S-2, S-3, S-4 and S-5 were located at various sites within Run Pond. A hydrolab data collector was utilized to measure the water temperature, specific conductance, dissolved oxygen, pH and salinity at the specific sampling locations. Samples were collected and sent to the Vermont State Laboratory for total nitrogen and total phosphorous analysis. See Section 5.c. Water Quality Evaluation for the sampling results.

c.   <u>Selection of Computer Model.</u> Analysis of any problem is generally restricted by time and budget constraints. This in turn influences the amount of data that can be collected, and controls selection of the tools needed to evaluate and predict effects of the proposed solution. In the case of Run Pond, a one-dimensional hydrodynamic model, UNET, was selected for the analysis since it would provide reasonable results without some of the difficulties of a 2-D model. The model was calibrated using the tide data collected on 4 May 2000.

UNET, using the properties of continuity and momentum, applies a linearized, implicit finite difference scheme to solve a set of linear equations. The program can simulate one-dimensional unsteady flow through a full network of open channels. For subcritical flow, stages are a function of channel geometry and downstream backwater effects. UNET provides the user with the ability to apply several external and internal boundary conditions, including flow and stage hydrographs, bridges, spillways, levee systems, and culverts. Cross-sections are input in a modified HEC-2 forewater format.

5. RESULTS

a. Model Calibration. Water surface elevations, measured on 4 May 2000, were used to calibrate the UNET model. Measured and estimated cross-sectional information and culvert characteristics were used to run the model. Manning's frictional "n" values (ranged from 0.035 in the channel to 0.07 on the overbanks) were adjusted so results more closely matched the observed tide level measurements. The existing culvert “n” values were 0.017 for the 48-inch RCP and 0.012 for the 36-inch HDPE. As stated previously, the existing pipes appear to be in good operating condition.

In addition, it was necessary to input tidal water surface levels for the ocean for the preceding two days leading up to the measurement, since as in the real situation, water levels build up in the marsh due to inadequate capacity of the outlet pipe. Running the model for the preceding two days also removes some of the instability in the calculations, inherent within finite difference computer models. Observed tidal conditions at Woods Hole, MA were used to estimate levels in Nantucket Sound for the previous two days.

Results of the calibrated run for 4 May 2000 is shown in Plate 6 and Plate 7 for gage locations where tide measurements were collected in the salt marsh. As can be seen, the computed results match very closely to the observed data. The high tide levels matched very closely while the computed low tide levels were 0.1 to 0.2 feet higher than the observed low tide levels. As stated previously, the model was not verified due to time and funding constraints.

b. Evaluation of Culvert and Open Channel Sizes.

(1) General. Various culvert and open channel sizes were evaluated for this study to determine what sizes are required to increase the high tide elevations in the marsh and increase flushing.

The topographic information provided by the town shows the vegetated areas around the marsh are above 2.7 ft NGVD. To verify this information, four spot elevations were taken in the vegetated area surrounding the southern end of the pond during the 2000 survey effort. The spot elevations show the vegetated areas to be at elevation 2.1 ft NGVD. The mean high tide, spring high tide and maximum predicted astronomical tide elevations in the open ocean near the project site are 1.7 ft NGVD, 2.0 ft NGVD and 2.1 ft NGVD, respectively. Therefore, it appears that the majority of the vegetated areas in the marsh are higher than the elevation to which the ocean tide rises under typical astronomical tide conditions. As such, even with a non-restrictive culvert in place, there is some question as to whether the high tide elevations are high enough to reach the majority of the vegetated areas in the marsh. Since it seems likely that total inundation of the vegetated areas will likely be limited to those times when storms cause the tide level to rise above roughly 3 ft NGVD, restoration was evaluated from a tidal flow and flushing perspective in addition to the flooding perspective.

(2) Culvert and Open Channel Evaluations - Water Surface Elevations. The intent of this investigation is to size a culvert and/or open channel large enough to allow the water level in the marsh to equal the water level in the ocean during high tides and to allow the water in the marsh to drain sufficiently during low tides. Manning's frictional 'n' value used for the proposed culverts was 0.017. It should be noted that a gate of some type will need to be installed on the new culvert and operated during storm events so that flooding of the low lying properties surrounding the pond does not occur. The following alternatives were investigated:

(a) replace the existing culvert with a 48 inch HDPE culvert.

(b) leave the existing 36-inch culvert in place and add a 24-inch culvert.

(c) leave the existing 36-inch culvert in place and add a 36-inch culvert.

(d) leave the existing 36-inch culvert in place and add a 48-inch culvert.

(e) leave the existing 36-inch culvert in place and add a 60-inch culvert.

(f) replace the existing culvert with two 5 ft by 10 ft box culverts

(g) replace the existing culvert with a 5 ft deep by 20 ft wide concrete open channel and two 5 ft by 10 ft box culverts beneath Shore Drive.

Table A-6 presents a summary of the maximum and minimum computed water surface elevations at various locations in the pond for the existing condition and for each alternative. Simulations were completed using the UNET model assuming minimal freshwater inflow and spring high tide conditions. The maximum computed water surface elevations in the pond were fairly constant through the entire extent of the pond. However, the minimum computed water surface elevations in the pond varied throughout the pond for each alternative considered.

As shown in Table A-6, the maximum water level for mean spring high tide in the marsh is 1.7 ft NGVD with the existing culvert. This is 0.3 ft lower than the spring high tide elevation in the open ocean (2.0-ft NGVD). The two 5 ft by 10 ft box culverts allowed the maximum water level in the marsh to rise to 2.0 ft NGVD. Alternatives (f) and (g) were the only alternatives successful in allowing the water level in the marsh to rise to the maximum water level of the open ocean. The 48-inch HDPE culvert did not have a significant impact on the maximum computed water level in the marsh.

Table A-6. Estimated Water Surface Elevations in Run Pond

Culvert Size	Dredgin (A or non	/S Culve Invert ft NGVD	Maximum Water Level in the Pond (ft NGVD)	Minimum Vater Leve the Southe Portion of Reach 3[2,3] (ft NGVD)	Minimum Water Leve the Northe Portion of Reach 3[2,4] (ft NGVD)	Minimum Vater Leve Reach 2[2,] (ft NGVD)	Minimum Vater Leve Reach 1[2,] (ft NGVD)
36" dia for 619' and 48" dia fo (EXISTING CONDITION)	none	-0.14	1.7	1.5	1.5	1.5	1.5
24 inch dia culvert & existing	A	-1.0'	1.6	0.7	DRY[7]	0.9	1.2
36 inch dia culvert & existing	A	-1.0'	1.7	0.4	DRY[7]	0.8	1.2
48 inch dia culvert & existing	A	-1.0'	1.8	0.3	DRY[7]	0.7	1.2
60 inch dia culvert & existing	A	-1.0'	1.8	0.2	DRY[7]	0.7	1.1
48 inch diameter culvert	A	-1.0	1.6	0.5	DRY[7]	0.8	1.2
two 5' x 10' box culverts	A	-1.0	2.0	DRY[7]	DRY[7]	DRY[7]	DRY[7]
open channel with two 5' x 10' box culverts at Shore Drive	A	-1.0	2.0	DRY[7]	DRY[7]	DRY[7]	DRY[7]

NOTES:

1) Dredging plan A assumes an approximately 50' wide channel will be dredged from STA 9+00 to STA 10+00. The purpose of dredging plan A is to accommodate the -1.0' NGVD culvert invert. STA 9+00 will be dredged to -1.0' NGVD, STA 9+75 will be dredged to -0.5' NGVD, and STA 10+00 will not be dredged.

2) Calculations were performed using spring tide conditions and a minimum rate of freshwater inflow into the pond (3 cfs).

3) The southern portion of Reach 3 extends from the culvert (STA 9+00) upstream to T2 (STA 14+80). The elevation of the pond bottom is approximately 0.0' NGVD in this segment.

4) The northern portion of Reach 3 extends from T2 (STA 14+80) upstream to T3 (STA 19+10). The elevation of the pond bottom is approximately 1.0 ft NGVD in this segment of the pond.

5) Reach 2 extends from T3 (19+10) upstream to the western limit of the pond at Run Pond Road at T6 (STA 8+80). The elevation of the pond bottom is roughly 0.0' NGVD in this segment of the pond.

6) Reach 3 extends from T3 (STA 19+10) upstream to the northern limit of the pond at Willow Street (STA 46+70). The average pond bottom elevation in the portion of this reach that is influenced by the tide is 0.85 ft NGVD.

7) "DRY" implies that the pond will drain to such an extent that there will be minimal/no water in the specified areas of the pond during low tide.

As seen in Table A-6, the minimum water level for mean spring low tide in the marsh is 1.5 ft NGVD with the existing culvert. All of the alternatives allowed the minimum water level in the marsh to drop lower than the existing minimum water level. The proposed 48-inch HDPE culvert with the –1.0 ft NGVD invert was the only alternative that kept the entire pond wet under both high and low tide conditions. With this alternative, the minimum water level in the marsh drops to 1.1 ft NGVD, 0.4 ft lower than the existing condition. All of the other alternatives significantly drained the pond at low tide.

With the existing culvert replaced by a 48-inch HDPE culvert with an invert of -1.0 ft NGVD, the minimum water level in the marsh drops by 0.3 ft to 1 ft depending on the location considered, with the exception of the northern portion of Reach 3. In the northern portion of Reach 3, where the elevation of the pond bottom is higher than the rest of the pond, it is likely that the pond bottom will be exposed (i.e. no water) with this alternative. The results are nearly identical when the existing culvert is used in conjunction with a new 48 inch HDPE culvert with an upstream invert of -1.0 ft NGVD.

With the existing culvert replaced by two 5 ft by 10 ft box culverts with inverts of -0.14 ft NGVD, the minimum water level in the marsh drops by roughly 1 ft in the southern portion of Reach 3 and in Reach 2. In the northern portion of Reach 3 and in the majority of Reach 1, it is likely that the pond bottom will be exposed (i.e. no water) with this alternative. This alternative provides both the required water surface elevation (2.0 feet NGVD) necessary to restore salt grasses and adequate tidal exchange within the marsh to improve water quality conditions.

The 5 ft x 20 ft wide concrete open channel with two 5 ft x 10 ft box culverts beneath Shore Drive alternative resulted in a minimum water level drop in the marsh of approximately 0.7 at Station 9+00 (Reach 3) and in Reach 2. In the northern portion of Reach 3 and in the majority of Reach 1, it is likely that the pond will go dry. This alternative also provides both the required water surface elevation (2.0 feet NGVD) necessary to restore salt grasses and adequate tidal exchange within the marsh to improve the water quality conditions.

(3) <u>Tidal Flushing - Amount of Water Leaving and Entering Pond.</u> In order to evaluate the various culvert alternatives from another perspective, the amount of salt water entering the pond during high tide and the amount of salt water leaving the pond during low tide were determined for the existing condition and for each alternative. The total volume of water that is currently in the pond was also estimated from the survey information and was used in computing the percent of water entering and leaving the pond. Simulations were completed using the model assuming minimal freshwater inflow and spring high tide conditions. The results are found in Table A-7.

As seen in Table A-7, the existing culvert restricts tidal flushing of Run Pond. All of the alternatives increase the amount of salt water leaving and entering the pond. The largest turn over of salt water is seen with both alternative (f), two 5 ft x 10 ft culverts and alternative (g), 5 ft x 20 ft concrete open channel with two 5 ft x 10 ft box culverts beneath Shore Drive. For comparison purposes, the amount of time it would take to drain the pond one pond volume and fill the pond one pond volume was computed for each alternative.

Table A-7. Estimated Volumes of Salt Water Entering and Leaving Run Pond, Mean Spring Tide Condition

Culvert Size	Dredging Plan (A or none)[1]	U/S Culvert Invert (ft NGVD)	Percent Increase of Water Volume Leaving the Pond During a 12-hour Period[2, 3] (low to high to low tide	Percent Increase of Water Volume Entering the Pond During a 12-hour Period[2, 4] (low to high to low tide)	Time Unit to Drain One Pond Volume and Fill One Pond Volume[5, 6] (hours)
36" dia for 619' and 48" dia for 276' (EXISTING CONDITION)	none	-0.14	280,000ft^3	50,200ft^3	52
24 inch dia culvert & existing culvert	A	-1.0'	40%	75%	23
36 inch dia culvert & existing culvert	A	-1.0'	50%	80%	17
48 inch dia culvert & existing culvert	A	-1.0'	58%	88%	14
60 inch dia culvert & existing culvert	A	-1.0'	60%	88%	13
48 inch diameter culvert	A	-1.0	50%	80%	18
two 5' x 10' box culverts	A	-1.0	65%	90%	11
open channel with two 5' x 10' box culverts at Shore Drive	A	-1.0	65%	90%	12

NOTES:

1) Dredging plan A assumes an approximately 50' wide channel will be dredged from STA 9+00 to STA 10+00. The purpose of dredging plan A is to accommodate the -1.0' NGVD culvert invert. STA 9+00 will be dredging to -1.0 ft NGV to -0.5' NGVD, and STA 10+00 will not be dredged.
2) Calculations were performed using spring tide conditions and a minimum rate of freshwater inflow into the pond (3 cfs).
3) Water leaves the marsh during low tide conditions when the water in the marsh is at a higher elevation than the water in the
4) Water enters the marsh during high tide conditions when the water in the ocean is at a higher elevation than the water in the
5) The total available volume of water in the pond under existing conditions was estimated to be 683,133 ft^3. This volume was unit to drain one pond volume and fill one pond volume.
6) The time to drain one pond volume and fill one pond volume was computed for comparision purposes only. This is not a ca to turn over a pond volume.

(4) <u>Potential Flooding During Storm Events.</u> Available survey information was studied to determine the elevations of low-lying roads and properties adjacent to the pond. Analysis was conducted to determine whether any of the proposed culvert alternatives would cause flooding to the low-lying properties adjacent to the salt marsh during storm events.

South Shore Drive, which runs along the southern end of the pond, has a minimum elevation of 5.7 ft NGVD. The town parking lot, the Bass River Beach, and various hotels are located south of South Shore Drive. At the narrowest and lowest point, approximately 700 ft of beach separates the ocean from the pond. This portion of beach is at a low elevation, ranging from 5.5 ft to 6.2 ft NGVD. As such, when tide levels of greater than approximately 6 ft NGVD (roughly a 11-year tidal event) are experienced, flooding of the pond will likely happen regardless of which culvert is selected because the wave overtopping will likely flood the beach, pass over the road and cause inundation of the salt marsh. As presented in Table A-2, the tide levels corresponding to the 100-yr and the 50-yr frequency flood events are 10.0 ft NGVD and 8.4 ft NGVD, respectively. Because these tide levels are higher than the adjacent beach, and floods of this magnitude would likely flood the entire pond and surrounding area, they were not considered in the culvert flooding analysis.

The 10-yr and the 1-yr frequency flood events, which have tide levels of 5.4 and 3.8 ft NGVD, were utilized in the analysis. Coincident high tides and significant runoff from rainfall events were considered, since high tides occur twice daily, increasing the probability of simultaneous tidal and interior flooding.

A 1-yr frequency tide level and a 5-yr frequency rainfall event were simulated for the two 5 ft by 10 ft box culverts and 5 ft by 20 ft open channel (invert = -1.0 ft NGVD) using the model (see Plate 9). This condition produced a maximum water level in the salt marsh of 3.6 ft NGVD, which is lower than the elevations of the surrounding homes.

A 10-yr frequency tide level and a 5-yr frequency rainfall event were simulated for the two 5 ft by 10 ft box culverts and 5 ft by 20 ft open channel (invert = -1.0 ft NGVD) using the model (see Plate 10). This condition produced a maximum water level in the salt marsh of 5.4 ft NGVD, which is lower than the first floor home elevations (minimum elevations of 6.1 and 6.4 feet NGVD at 106 Breezy Point Rd and 90 Breezy Point Rd, respectively). However, this 5.4 feet NGVD elevation is higher than the basement (elevations of 4.0 and 4.7 feet NGVD at 6 Crescent Court and 108 Breezy Point Rd, respectively) and garage (5.5 feet NGVD) elevations of some of the other surrounding roads and homes. With this condition, a 450 ft long stretch of Run Pond Rd will likely flood, the western end of Crescent Court will likely flood, and it is possible that the lower level of the split level home located at 6 Crescent Court will flood. Although, the roadway will be overtopped during a tidal event greater than a 10-yr regardless of the culvert size, it is recommended tide gates be installed to prohibit tidal flooding to these low lying properties during 2-yr to 10-yr tide events due to the large culverts.

The 10-yr frequency tide level and 5-yr frequency rainfall event was also simulated for the alternative of leaving the existing culvert in place and supplementing it with a 48-inch HDPE culvert with an upstream invert of -1.0 ft NGVD. With this condition, the maximum computed water level in the salt marsh was 3.4 ft NGVD, which is lower than the elevations of the surrounding homes and roads. However, the water level in the marsh at the end of the 10-yr tide event is approximately 2.7 ft NGVD, higher than the average water level. If the tide level was to remain elevated for more than one tide cycle, which would hinder draining of the pond, it is likely that water levels in the pond would rise above the elevations of the low-lying properties. Based on these findings, it is recommended that tide gates be installed on proposed culverts. The gates will need to be operated anytime coastal storms cause the tide level to elevate significantly.

c. Water Quality Evaluation. Run Pond experiences extensive algae growth during the summer months. The cause of these algae blooms is thought to be a combination of elevated nutrient loading and minimal tidal flushing of the pond.

Excessive nutrient loadings promote the growth of aquatic vegetation, which in turn become oxygen-demanding material, decreasing the dissolved oxygen (DO) concentrations in the system. The two major nutrients of concern that stimulate algae and plant growth are nitrogen and phosphorous. The source of excessive nutrients in a pond may be from sediments, groundwater inflow, or surface water runoff. The algae and other aquatic vegetation undergo photosynthesis during the daylight hours producing oxygen. During the night hours, this vegetation undergoes respiration working as a continuous oxygen sink depleting the dissolved oxygen in the water. In the presence of excessive nutrient levels and significant algae growth, supersaturated DO levels occur during photosynthesis and very low DO levels occur during respiration.

The Surface Water Quality Standards for the Commonwealth of Massachusetts (MWQS), coastal and marine classes, provides specific water quality guidelines used in this water quality evaluation of Run Pond. Coastal and marine class SA includes waters designed as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas, they shall be suitable for shellfish harvesting without depuration (open shellfish areas) and have excellent aesthetic value. Per the MWQS, the DO should not be less than 6.0 mg/l, temperature shall not exceed 29.4 degrees Celsius, and the pH shall be between 6.5 and 8. Fecal coliform shall not exceed a geometric mean of 14 organisms per 100 ml for waters with open shell fishing or 200 organisms for waters without open shell fishing.

The Environmental Protection Agency (EPA) Quality Criteria for Water 1986 was referenced to evaluate the nutrient concentrations of Run Pond. In order to avoid growth of nuisance vegetation, such as algae, it is recommended that total phosphorous concentrations be less than 0.10 ug/l for marine or estuarine water. The EPA does not provide a not to exceed criteria for total nitrogen in estuarine waters. However, industry standard recommends total nitrogen concentrations be less than 0.1 mg/l in estuarine waters.

The Army Corps of Engineers (COE) collected water quality samples on the 18 July 2001 and the 8 August 2001 to measure the DO concentrations. Results of the 18 July and 8 August sampling event indicated total nitrogen concentrations ranging between 0.24 to 1.00 mg/l and total phosphorous concentrations ranging between 0.20 to 0.98 ug/l. Per the EPA, phosphorous should be less than 0.1 ug/l and per industry standards nitrogen should be less than 0.1 mg/l in aquatic systems to avoid growth of algae. Therefore, total nitrogen and phosphorous concentrations recorded at Run Pond indicate a very high presence of nutrients. As stated previously, excessive nutrient loadings promote the growth of aquatic vegetation,. Results of the COE water sampling are presented in Table A-8.

During the 18 July sampling event, the weather was warm and sunny. Results of this event recorded DO concentrations in the pond between 4.0 mg/l at station S-1 and 12.1 mg/l at station S-5. As shown in Table A-8, the DO concentrations increased during the course of the day (i.e. sample S-1 was taken at 8:40 am and sample S-5 was taken at 12:00 pm). During the sampling at station S-5, the air temperature was near 90 degrees F and sunny, supporting high photosynthesis conditions which, created supersaturated DO conditions.

During the 8 August sampling event, an attempt was made to record DO concentrations before the photosynthesis of the algae mats in Run Pond could create atypically high dissolved oxygen levels. Readings were taken about 1.5 hours earlier in the morning when DO would be depleted due to respiration. As with the previous sampling on 18 July, the weather conditions were warm and sunny. The DO values taken at station S-2, and station S-3, were 3.32 mg/l and 3.24 mg/l respectively, which is considerably below the MWQS DO requirement of 6.0 mg/l.

Fecal coliform bacteria are an indicator of contamination. Fecal coliform is a bacterium that can be found within the intestinal tract of all warm-blooded animals. Therefore, fecal coliform can be found in the fecal wastes of these animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. Elevated concentrations of fecal coliform indicate the likelihood of increased pathogenic organisms. . The City of Yarmouth provided fecal coliform concentrations collected from Run Pond on the 11 July 2000, 17 July 2000, 14 August, 2000, 21 August 2000, 5 September 2000, and the 25 September 2000. These concentrations ranged between 10 and 2000 (colony forming units) CFU/100ml and were analyzed by the Barnstable County Health Laboratory and prepared for the Yarmouth Department of Natural Resources. As stated previously, fecal coliform shall not exceed a geometric mean of 14 organisms per 100 ml for water with open shell fishing or 200 organisms for waters without open shell fishing, per the MWQS. Therefore, these levels exceed recommended standards. The pond is closed to shell fishing. The source of fecal coliform to the pond is not known.

According to the Environmental Protection Agency publication, EPA-822-B-01-003, Nutrient Criteria Technical Guidance Manual, estuaries that flush more rapidly will export nutrients more rapidly than those that flush more slowly, resulting in lower nutrient concentrations in the estuary. This study supports the hypothesis that an increase in flushing with saturated DO concentrations from the ocean into Run Pond will decrease (dilute) nutrient levels in the water, increase the DO concentration in the water, discourage the growth of aquatic vegetation (algae) and therefore, improve the water quality conditions of the pond. However, increased flushing of Run Pond will not improve any sediment oxygen demand (SOD) exerted by organics in the sediments of Run Pond, as significant dredging of the pond is not proposed. However, with the more frequent exchange of oxygenated water from the Bass River and Nantucket Sound, it is likely that dissolved oxygen levels will improve.

Table A-8. Results of Water Quality Sampling, Run Pond, Yarmouth, MA

18 July 2001					
	S-1	S-2	S-3	S-4	S-5
Time	8:40am	9:10am	10:00am	11:00am	12:00pm
Water Temp ©	23.18	22.98	24.85	27.6	23.5
Sp. Cond. (umhos)	43.2	45.4	45.5	10.88	23.9
DO (mg/l)	4.02	6.60	7.90	7.92	12.07
pH	7.85	7.90	8.02	6.43	8.35
Salinity (ppt)	27.7	29.29	29.3	6.22	14.2
Total N (mg/l)	0.24	0.52	0.54	1.00	0.75
Total P (ug/l)	0.38	0.55	0.31	0.20	0.98
8 August 2001					
	S-1	S-2	S-3	S-4	S-5
Time	7:25am	7:58am	8:25am	NS	10:15am
Water Temp ©	25.59	24.49	25.9	NS	31.4
Sp. Cond. (umhos)	43.1	38.0	42.0	NS	16.5
DO (mg/l)	4.28	3.32	3.24	NS	8.0
pH	7.85	7.91	7.97	NS	.98
Salinity (ppt)	27.56	23.68	26.85	NS	27.77
Total N (mg/l)	0.48	0.54	0.64	NS	0.80
Total P (mg/l)	0.44	0.37	0.42	NS	0.77

NS – samples were not collected at station S-4 during the 8 August 2001 sampling event.

6. SUMMARY AND RECOMMENDATIONS

A hydrologic and hydraulic analysis was conducted to assess the tidal conditions within the Run Pond salt marsh and to determine the culvert and/or open channel size required to improve tidal flow in and out of the marsh. This study included development of a one-dimensional model to evaluate the tidal flow and water quality sampling to provide a cursory water quality analysis of the salt pond.

Measurements of tidal movement in Run Pond were recorded during a May 2000 spring tide event and showed that the existing culvert significantly restricts the tidal flushing of Run Pond. The water level in the marsh fluctuates only 0.2 ft under existing conditions.

A one-dimensional hydrodynamic computer model, developed by HEC (UNET), was used to simulate tidal movement into and out of Run Pond. The model was calibrated using water surface elevations collected on 4 May 2000 and then was used to predict tidal movement for various culvert sizes. During final design additional monitoring and modeling will be run for verification. Culvert sizes were evaluated based on the water levels in the marsh and flushing capabilities.

Based on the hydraulic analysis, there are numerous alternatives that would improve both the water level fluctuations within the marsh and the volume of saltwater exchange within the marsh. The proposed alternatives range from simply replacing the existing culvert with a 48-inch culvert with a lower upstream invert elevation to replacing the existing culvert with two 5-ft by 10-ft box culverts.

The two 5 ft by 10 ft box culverts and 5 ft by 20 ft open channel are the only two alternatives that allow the water level in the marsh to rise to the level of the ocean tide. These two alternatives also provide the largest volume of saltwater exchange between the pond and the ocean. The smallest culvert needed to cause a noticeable fluctuation in water level is a 48-inch HDPE culvert with an upstream invert of -1.0 ft NGVD. Although the 48-inch HDPE culvert does not provide the level of flushing that is seen with the two 5 ft by 10 ft box culverts and 5 ft by 20 ft open channel, this alternative allows approximately 50% more water to enter the marsh and 85% more water to leave the marsh than the existing culvert does.

It should be noted that the majority of alternatives modeled caused at least a portion of the pond to run dry during low tide. This does not happen under existing conditions. Also, a closure capability or a tide gate will need to be installed to prevent flooding of low-lying areas surrounding the pond during coastal storms. Sluice gates/self regulating tide gates could be considered. It should also be noted that depending on which alternative is selected, entrance/exit riprap protection might be needed.

A cursory water quality analysis was conducted of Run Pond to determine if increasing the tidal flushing will discourage the growth of aquatic vegetation (algae) and improve the water quality conditions of the pond. Water quality samples collected by the COE on the 18 July 2001 and 8 August 2001 measured a high presence of total nitrogen and phosphorous, which promotes the growth of aquatic vegetation. Fecal coliform bacteria levels provided by the City of Yarmouth also indicated elevated levels. The source of the nutrient and the bacteria are not known. However, the area around the pond depends on sub-surface on-site wastewater disposal (septic systems). If these systems are not functioning properly, they may be contributing nutrients and bacterial contamination to the pond. It is the local community’s responsibility to ensure that these systems are functioning properly. Other source of nutrients and bacteria may be storm water runoff to the pond and for nutrients potential release of nutrients from pond sediments.

According to the U.S. EPA publication, EPA-822-B-01-003, Nutrient Criteria Technical Guidance Manual, estuaries that flush more rapidly will export nutrients more rapidly than those that flush more slowly, resulting in lower nutrient concentrations in the estuary. This study supports the hypothesis that an increase in flushing from the ocean into Run Pond will improve water quality in the pond. It is likely, that lower nutrient concentrations will result in decreased growth of the nuisance alga mats.

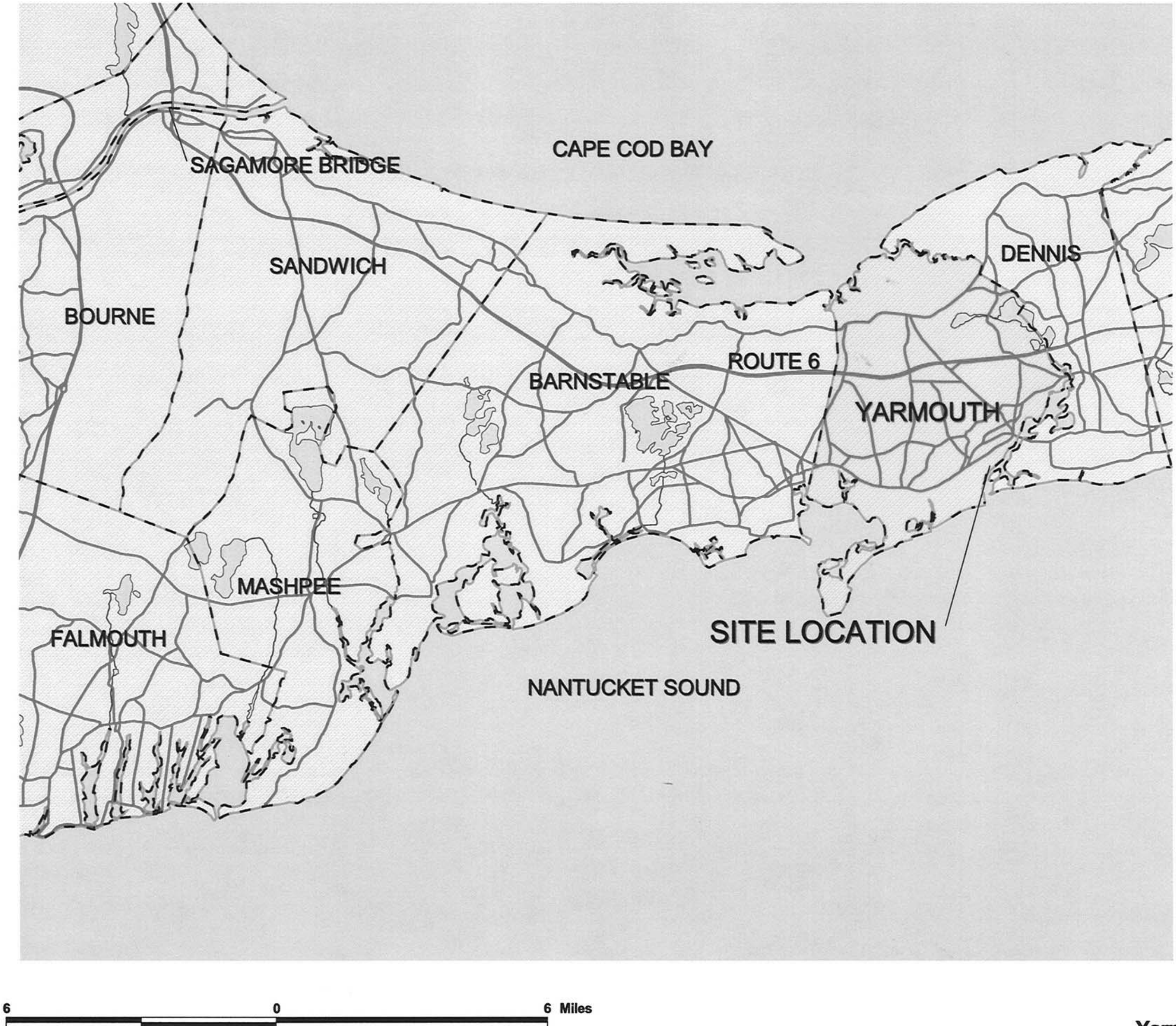

PLATE 1
Location Map
Run Pond
Yarmouth, Massachusetts

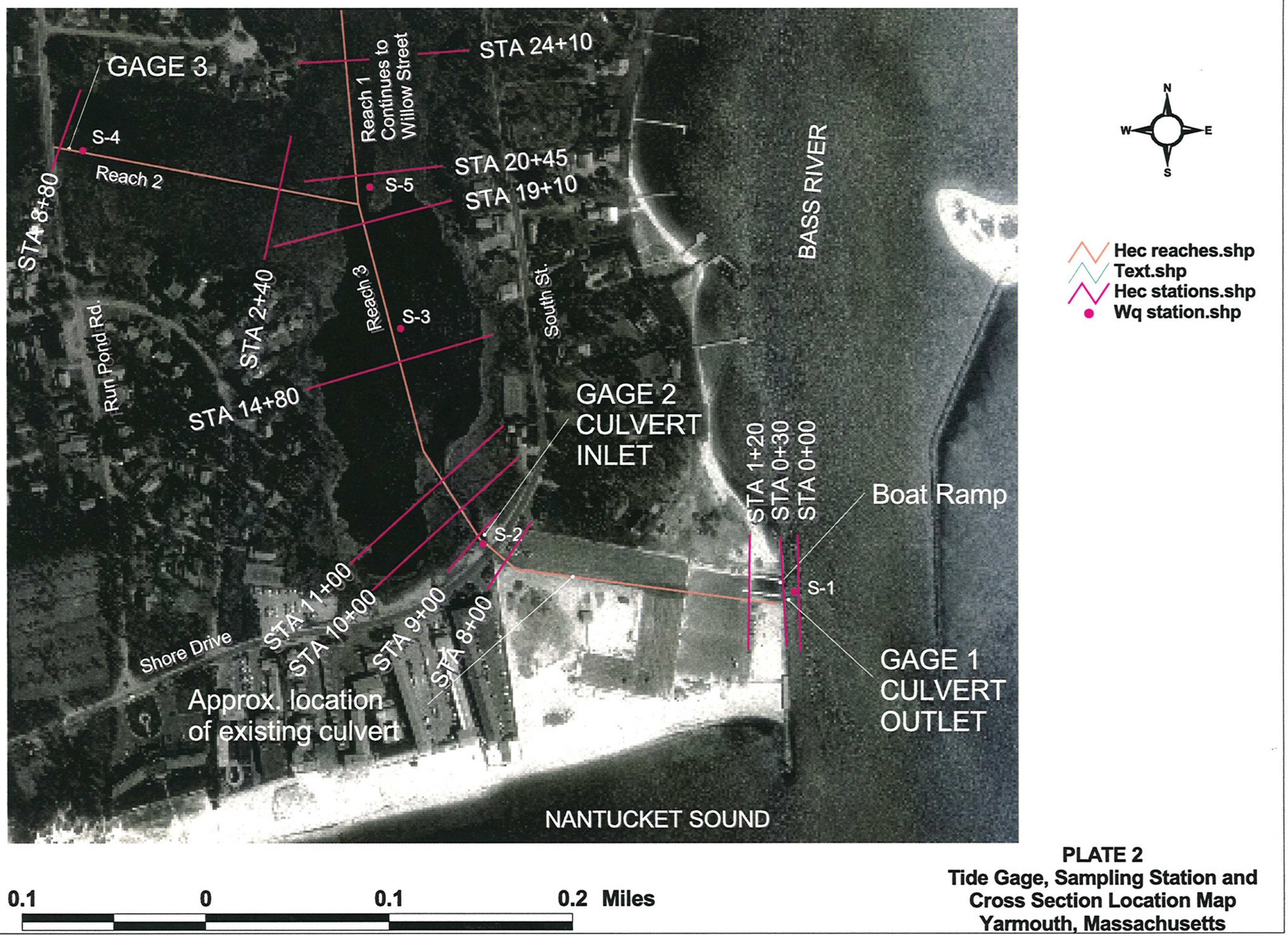

PLATE 2
Tide Gage, Sampling Station and Cross Section Location Map
Yarmouth, Massachusetts

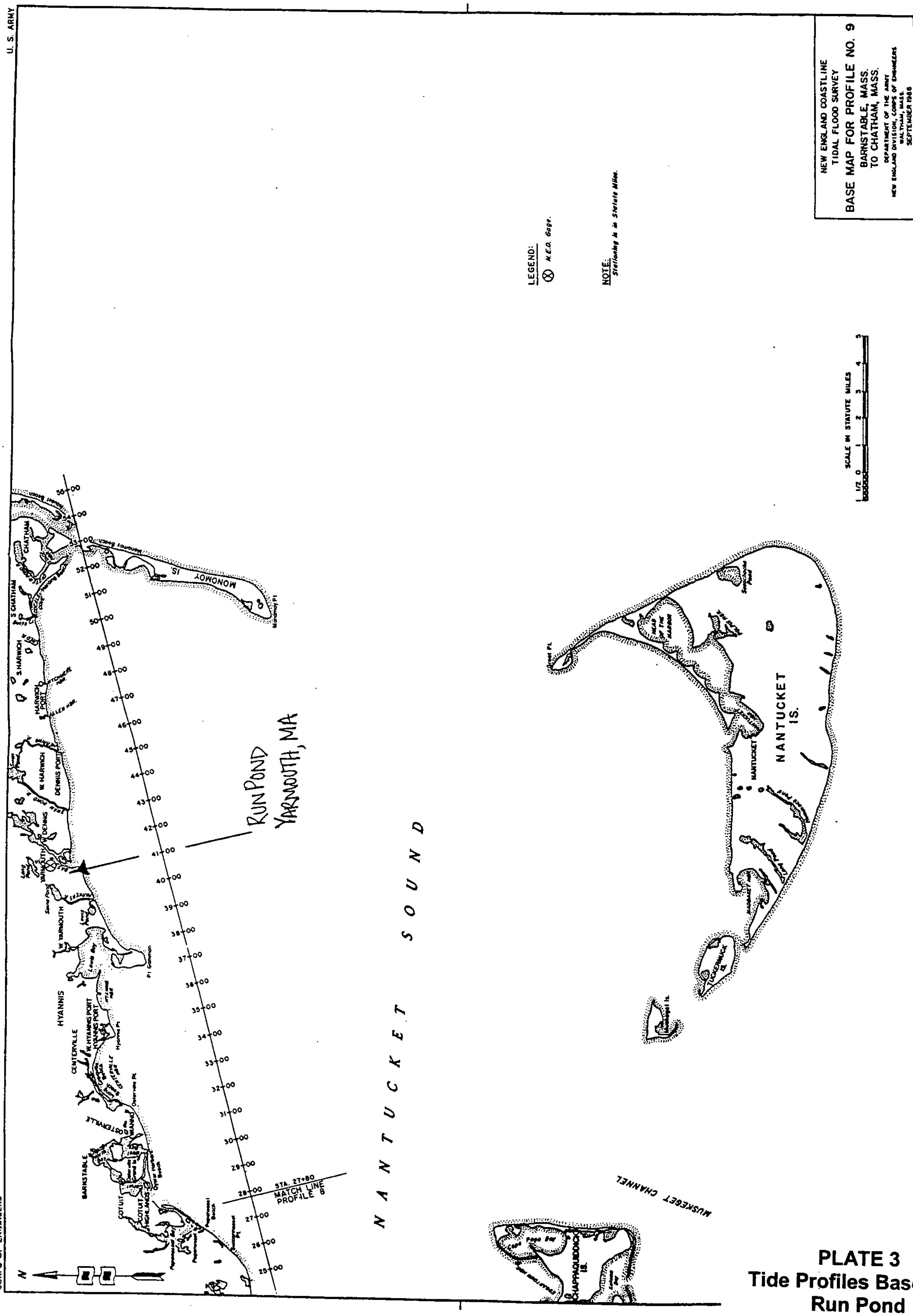

PLATE 3
Tide Profiles Base Map
Run Pond
Yarmouth, Massachusetts

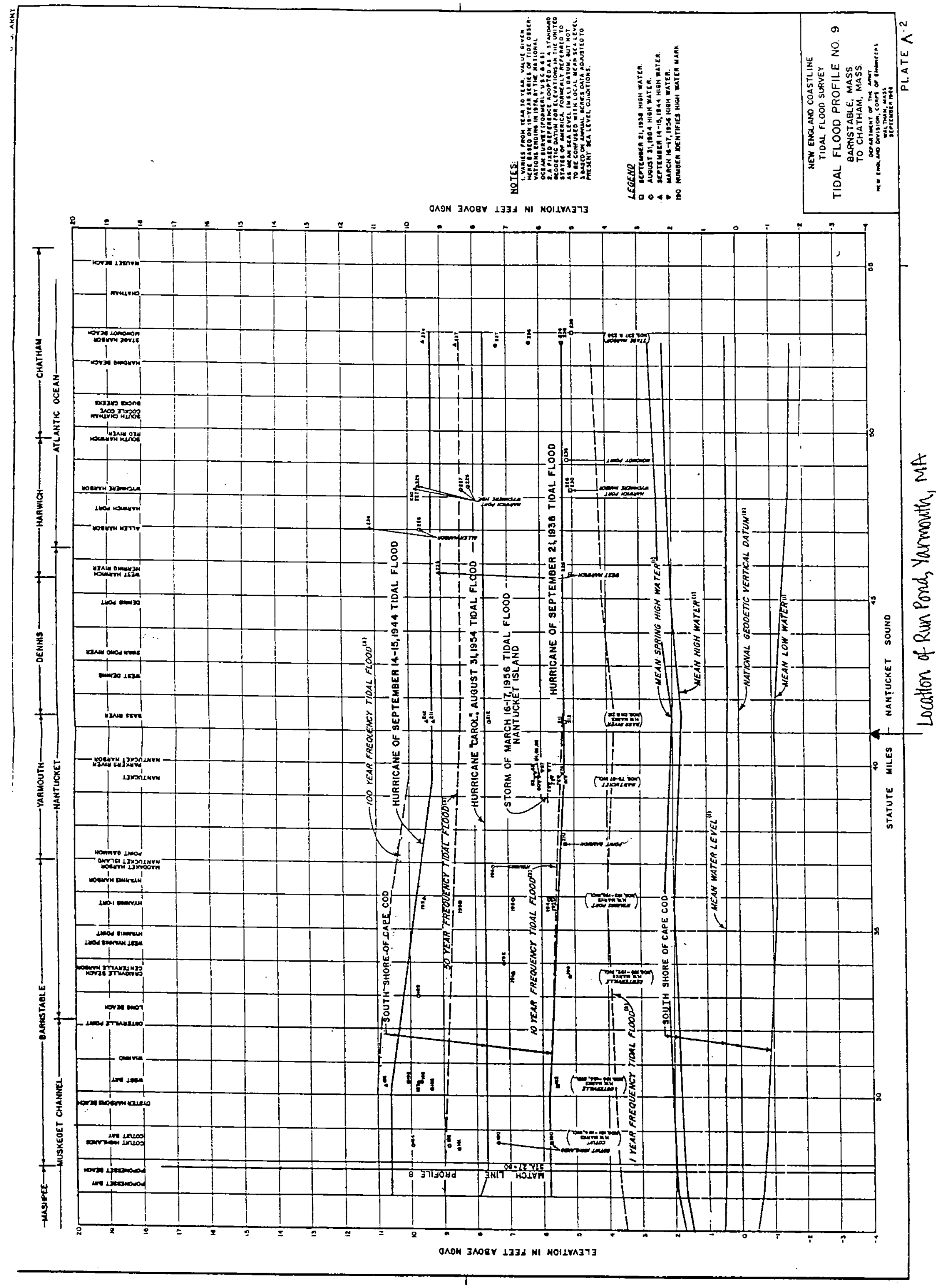

PLATE 4
Tide Profiles
Run Pond
Yarmouth, Massachusetts

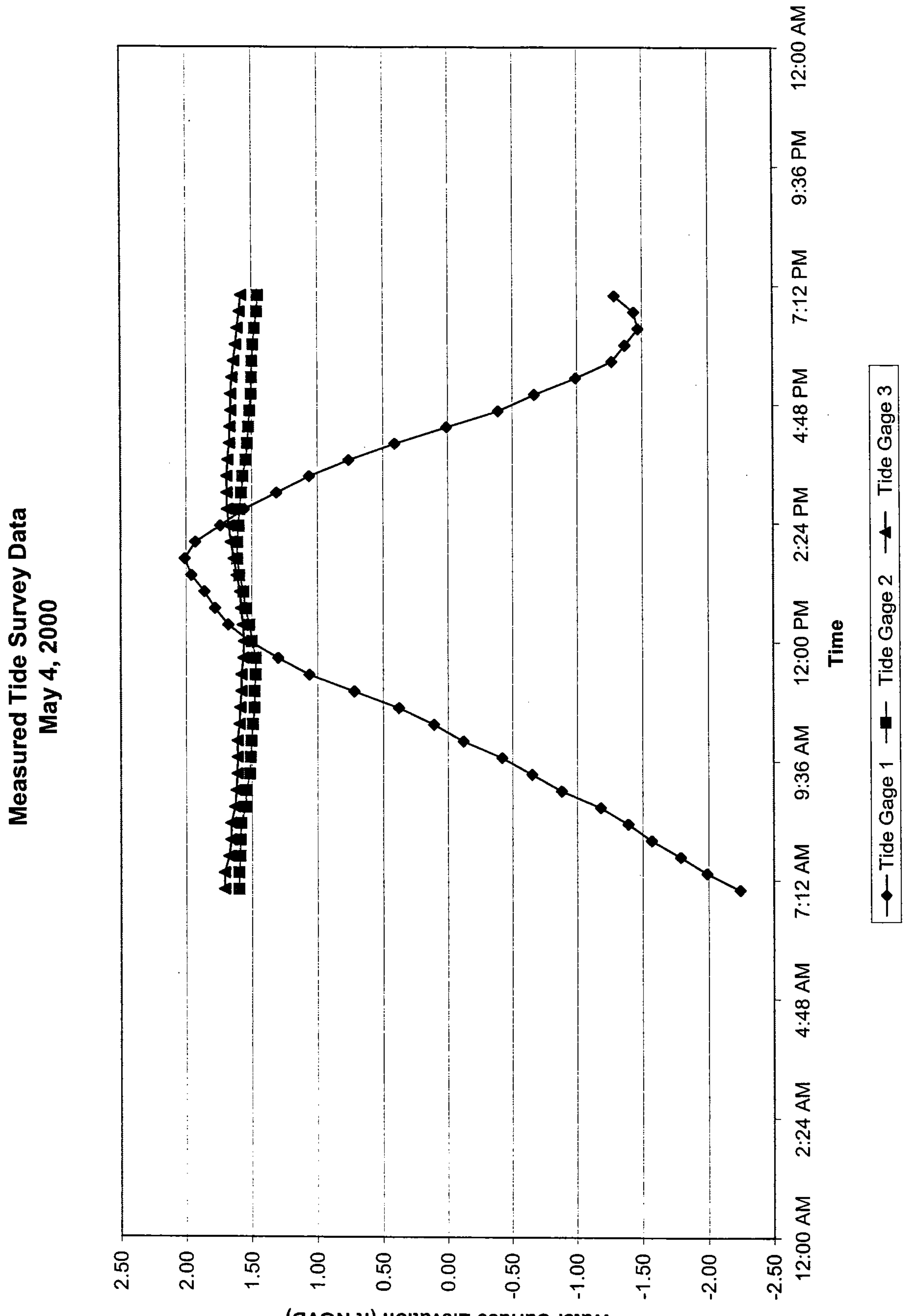

PLATE 5
Measured Tide Survey Data
Run Pond
Yarmouth, Massachusetts

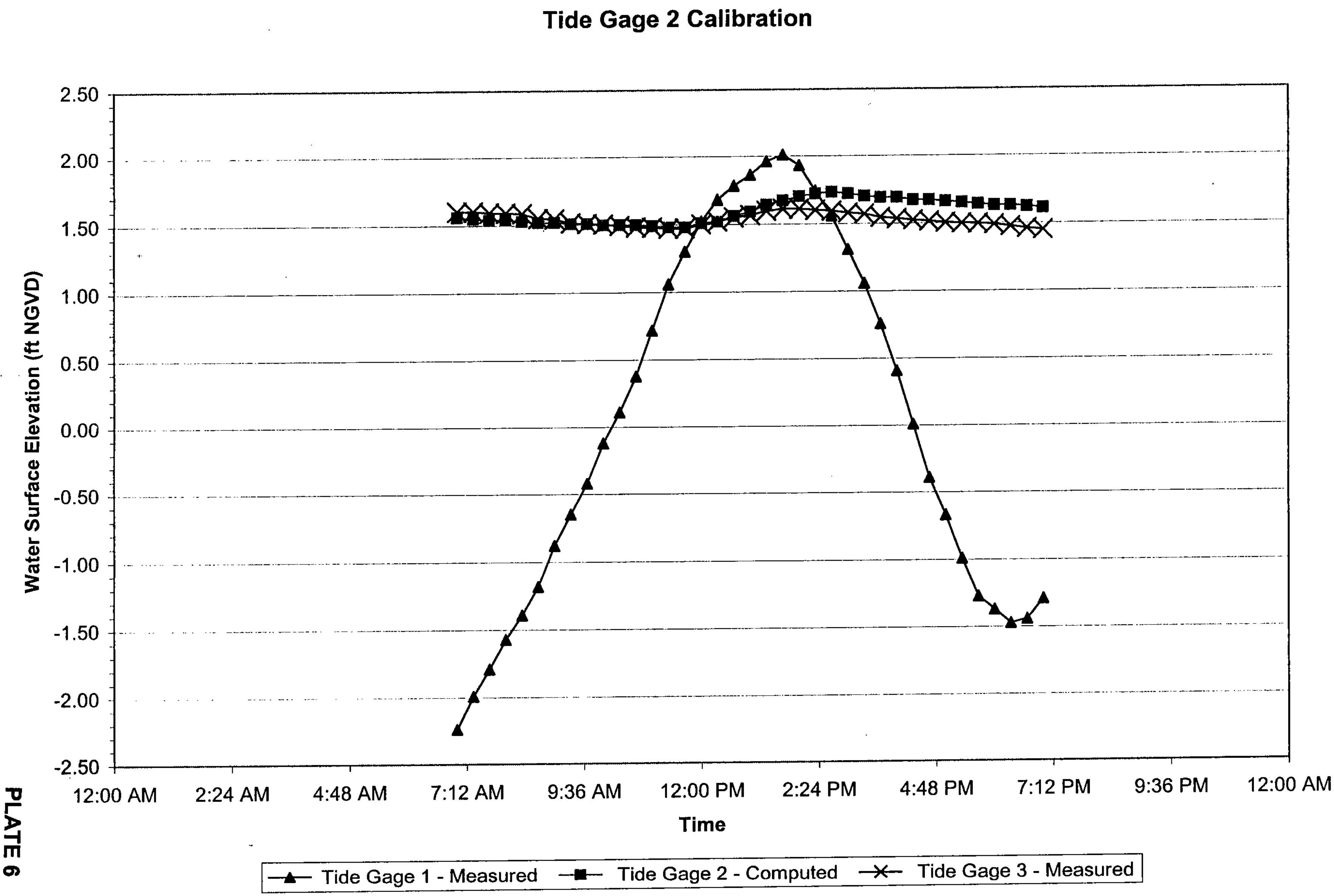

PLATE 6
Tide Gage 2 Calibration
Run Pond
Yarmouth, Massachusetts

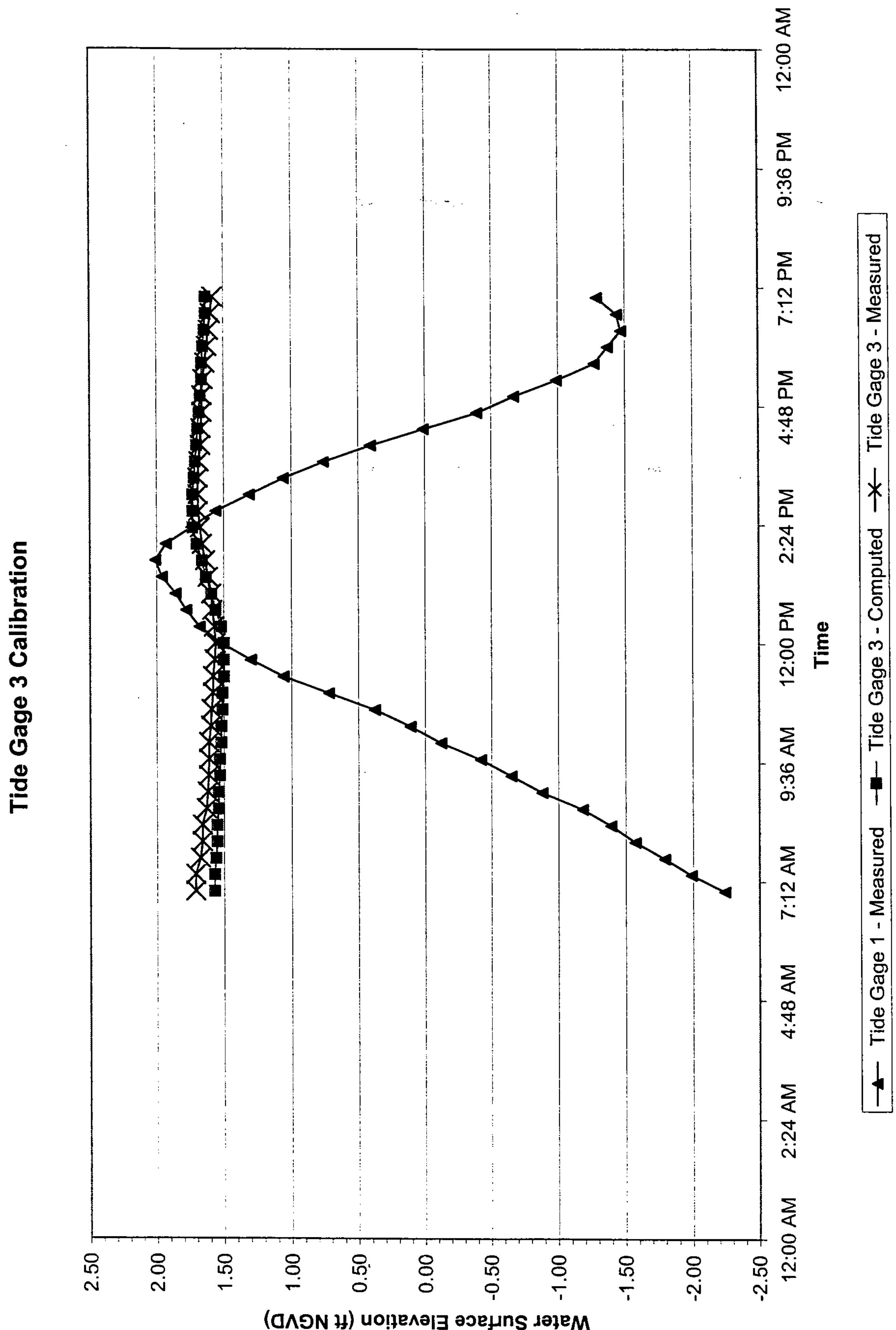

PLATE 7
Tide Gage 3 Calibration
Run Pond
Yarmouth, Massachusetts

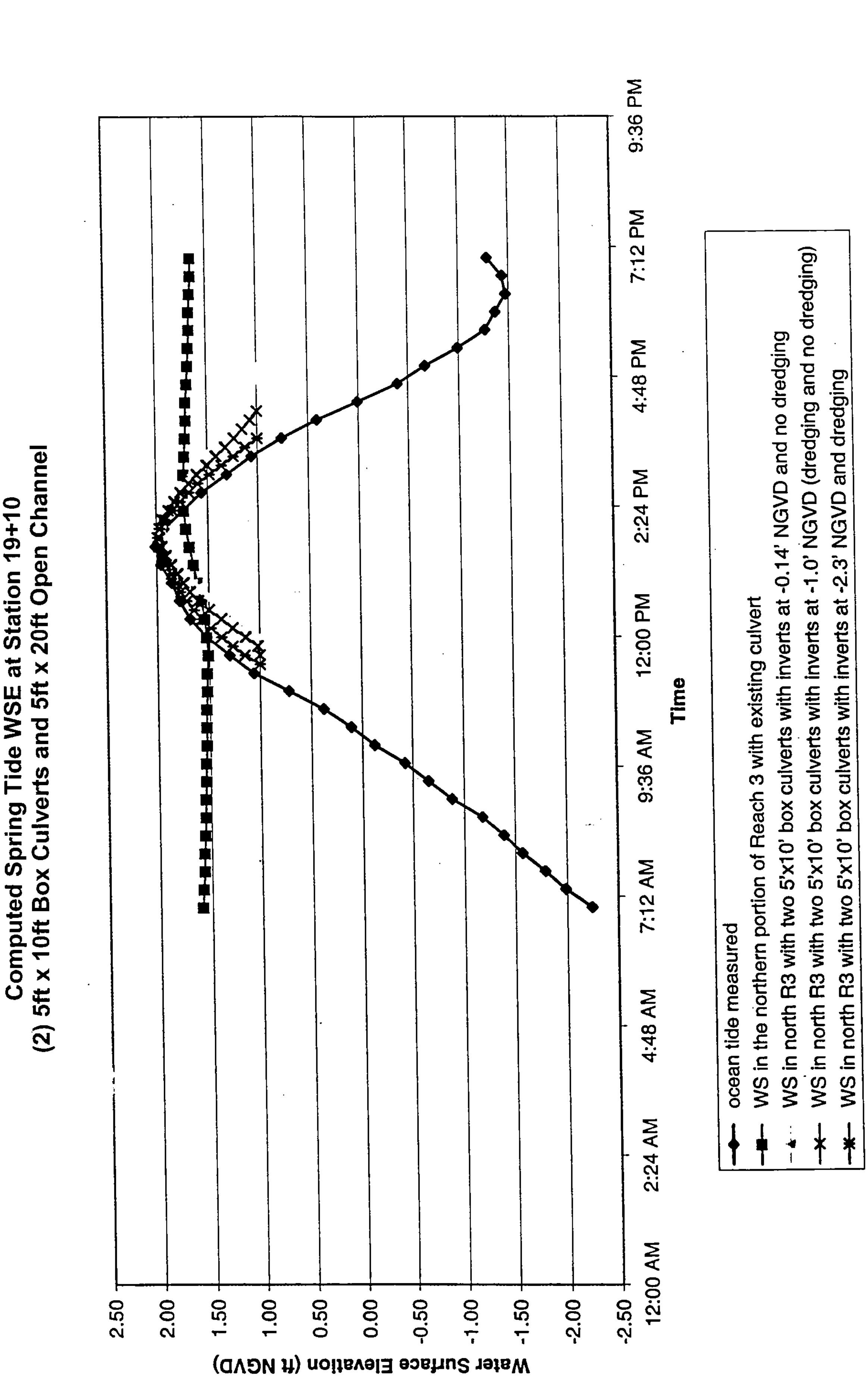

PLATE 8
Computed Spring Tide WSE at Station 19+10
(2) 5ft x 10ft Box Culverts and 5ft x 20ft Open Channel
Yarmouth, Massachusetts

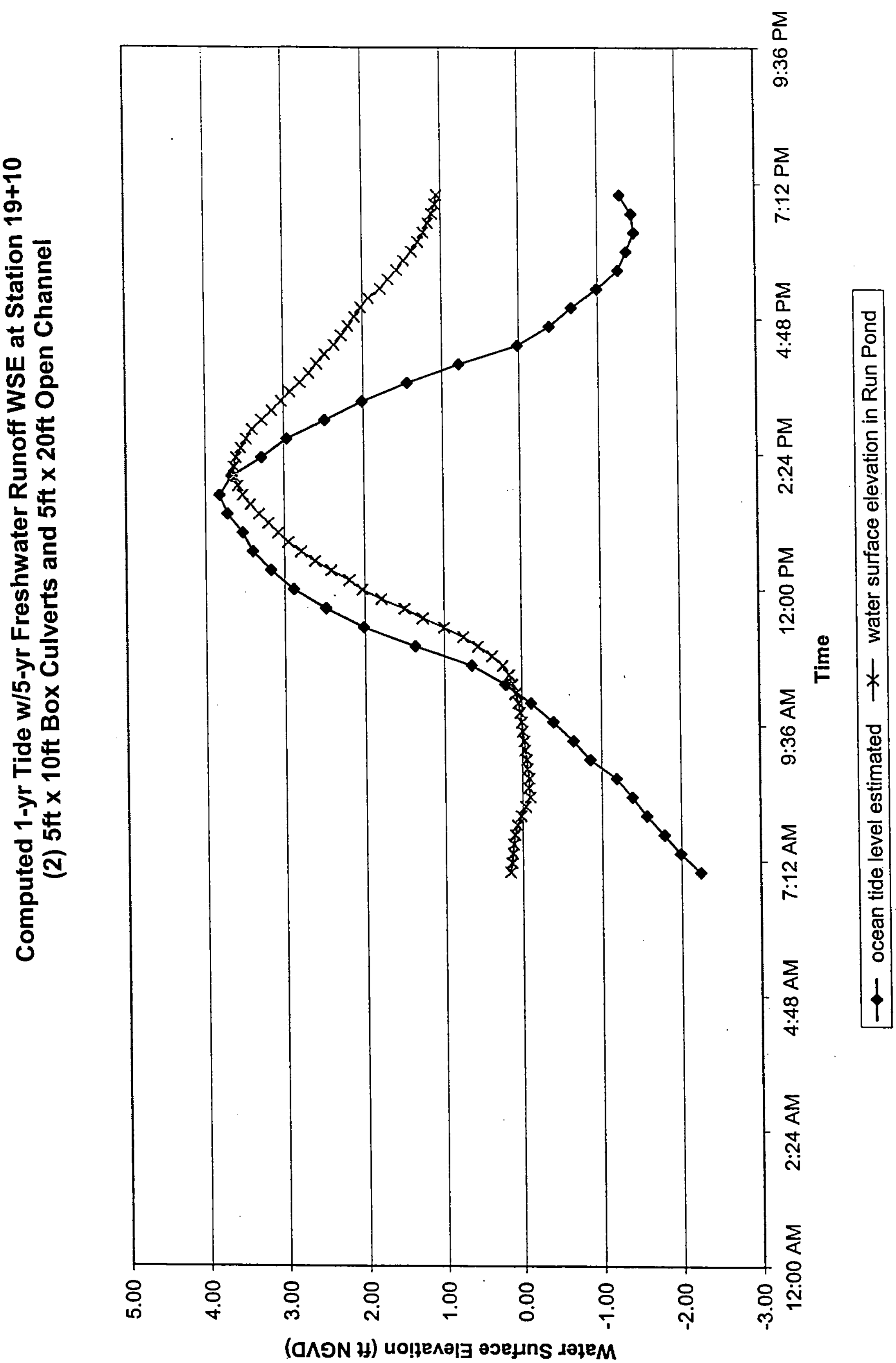

PLATE 9
Computed 1-yr Tide w/5-yr Freshwater Runoff WSE at Station 19+10
(2) 5ft x 10ft Box Culverts and 5ft x 20ft Open Channel
Yarmouth, Massachusetts

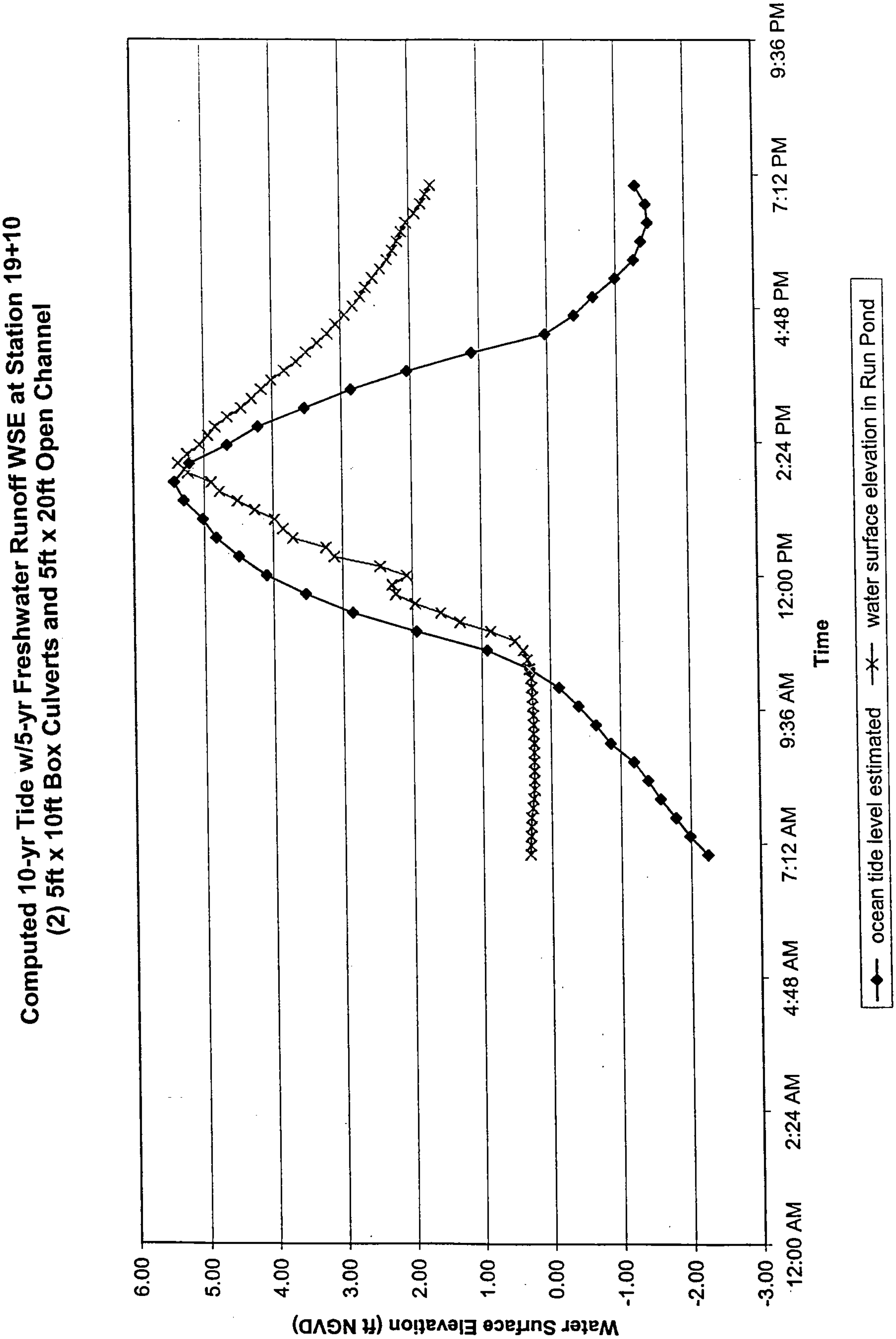

PLATE 10
Computed 10-yr Tide w/5-yr Freshwater Runoff WSE at Station 19+10
(2) 5ft x 10ft Box Culverts and 5ft x 20ft Open Channel
Yarmouth, Massachusetts

APPENDIX B. BENTHIC RESOURCES

APPENDIX B

Benthic Invertebrates from Run Pond, Yarmouth Massachusetts.

Prepared by:
Sheldon D. Pratt
13 Sherman Court
Wakefield, R.I. 02879
September 21, 2000

Background

Crowell Pond (called Run Pond locally) lies behind Bass River Beach in Yarmouth Massachusetts. A freshwater creek enters the north end of the pond. Salt water from Nantucket Sound enters the southern end of the pond through a long culvert. The New England District, Corps of Engineers is planning a restoration of the wetland. NED obtained twelve core samples along the length of Run Pond to assess the pre-restoration condition of benthic invertebrate communities there. Stations were identified by letters A-G and I-N from the south to the north end of the pond. The samples were transported to the University of Rhode Island by Corps personnel for sieving, and identification and enumeration of organisms.

Methods

Fresh core samples were sieved with filtered seawater to 0.5 mm and preserved in 10% formaldehyde with 0.1% rose Bengal stain. Samples were kept in formaldehyde solution until they were processed. At the time of processing the samples were washed on a 0.5mm sieve to remove preservative and remaining fine sediment and then passed through a 2mm sieve. The material retained on the 2 mm. screen was sorted without magnification from glass trays. The remaining material was repeatedly suspended in a tall pitcher and the low-density fraction (including organic detritus and most organisms) was separated from heavy material (sand, mollusks) by decantation. All fine fractions were examined under low-power dissecting microscopes. Notes were made of the sediment residue that remained after sorting was completed.

Organisms were identified to species in most cases. Counts of organisms and the volume of sample residue were entered on a MS Excel spread sheet (Table B-1). Identified organisms were preserved in 70% alcohol and archived at the University of Rhode Island Graduate School of Oceanography.

Results and Discussion

Constituents of sieve residues are given at the bottom of Table B-1. Most samples contained both sand and fine plant particles. Only sand was found in sample C residue. A larger volume of coarse material was found in upstream cores; gravel in cores M and N contained what appeared to be fresh water stream gravel. The sample nearest the culvert contained *Zostera* leaves, indicting transport from Nantucket Sound or the Bass River. Several of the taxa present were represented by a few very small individuals and could not be identified to the species level (anemone, *Odostomia*). The isopod, *Scyphacella arenicola* may have been introduced to sample A from the shore. The single fish listed was not included in the counts of species and individuals.

Numbers of species and individuals per sample are given at the top of Table B-1. No benthic invertebrates were found in samples C, G, N and only one individual was found in sample I. Samples A and B contained numbers of species and individuals typical of coastal ponds in this region with relatively high salinities water (polyhaline). The species found in samples A and B are characteristic of estuarine habitats with a degree of stress, but an abundance detrital food. The remaining samples contained low numbers of species (2-5) consistent with stressed environments. Samples in the mid portion of the pond had generally low numbers of individuals. At the head of the pond (samples J, L, M) numbers of individuals were increased by the presence of species adapted to freshwater or near-freshwater conditions (chironomids, oligochaetes, the amphipod, *M. mucronatus*).

Some of the species present in Crowell Pond are considered to be indicators of pollution (*Capitella capitata, Hypereteone heteropoda, Neanthes succinea, Polydora cornuta*) however it is easy to explain their presence in this location to a physically stressful environment and an abundance of detrital food.

Acknowledgment

Elliot Campbell carried out sample sorting.

Table B-1. Benthic organisms from Crowell Pond, Yarmouth, MA (sieve 0.5mm)												
SAMPLE	A	B	C	D	E	F	G	I	J	L	M	N
NUMBER OF SPECIES	18	11	0	2	5	2	0	1	2	3	2	0
NUMBER OF INDIVIDUALS	100	50	0	6	26	2	0	1	29	17	24	0
NIDAREA												
Anemone sp.	1	3			4	1						
NEMATODA	12	33		2	11							
NEMERTINEA												
nemertinea sp.	2											
MOLLUSCA												
GASTROPODA												
Crepidula fornicata		2										
Odiostoma sp.	2											
BIVALVIA												
Gemma gemma	45	1										
Mya arenaria spat	2											
ANNELIDA												
POLYCHAETA												
Capitella capitata	12	4			8							
Glycera americanus	1											
Heteromastus filliformis	4											
Hypoeteone heteropoda	3											
Leitoscoloplos fragilis		1										
Neanthes succinea		2										
Polydora cornuta	4	1										
Polychaeta frag	1											
OLIGOCHAETA												
oligochaete sp	5	1				1				5	18	

CRUSTACEA												
OSTRACODA												
Cylindroleberis mariae	2			4	1					2		
ISOPODA												
Edotea triloba	1											
Scyphacella arenicola	1											
AMPHPODA												
Mucrogammarus mucronatus					2				15			
Microdeutopus gryllotalpa		1										
Paracaprella tenuis	1	1										
INSECTA												
Chironomidae sp.								1	14	10	6	
ECHINODERMATA												
Leptosynapta tenuis	1											
fish (not counted above)												
Fundulus heteroclitus									1			
Sieve residue volume (cc)												
>2 mm sieve	10	5	tr	tr	75	tr	tr	60	100	125	60	25
2-0.5 mm sieve												
sand	50	80	100	55	5	75	30	10	tr	tr	130	150
fine plant detritus	20	15	tr	10	75	10	30	100	175	tr	tr	5

APPENDIX C. ECOLOGICAL BENEFITS

Appendix C

Run Pond

Yarmouth, Massachusetts

Ecological Benefits

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INTRODUCTION

The United States Army Corps of Engineers, New England District (USACE/NED), is studying habitat restoration opportunities at Run Pond, a 30 acre coastal salt pond/marsh wetland in Yarmouth, Massachusetts (Figure 1). Tidal exchange is restricted by an undersized 900 ft. long culvert. Reduced tidal flushing and nutrient influxes to Run Pond cause extensive algal blooms in the summer. The blooms result in diurnal swings in dissolved oxygen in the pond and evening dissolved oxygen depletions Reduced tidal flushing has also degraded salt marsh vegetation, allowing freshwater plants such as cattail, purple loosestrife and *Phragmites* to replace *Spartina* and other salt marsh grasses.

This appendix presents the results of a habitat benefits analysis. The habitat benefits analysis quantifies benefits of the alternatives in terms of "habitat units", a measure of both habitat quantity and quality. This information is an important component to the cost effectiveness/incremental cost analysis that integrates information about project costs and benefits (habitat units) to identify those restoration plans which are most cost effective in providing environmental benefits (outputs), eliminates inefficient plans, and determines if plans are cost effective. The analysis aids decision making by ensuring that the least cost solution ("Best Buy Plan") is identified for all possible levels of environmental outputs.

ENVIRONMENTAL QUALITY GOALS AND OBJECTIVES

Prior to beginning a restoration project it is important to establish and agree to the goals and objectives. These statements form the basis of project design and evaluation. Goals refer to the target characteristics to be restored, such as water quality, hydrology, or wetland flora and fauna. Objectives are more precise, such as the specific characteristics of water quality to be achieved or the species composition of the various communities of biota to be restored.

Goals

- Identify and recommend an effective, affordable and appropriate ecosystem restoration plan for Run Pond. The plan should be acceptable to the public, local sponsors, and resource and regulatory agencies.

- Restore a combination of tidal creek, salt pond, intertidal flats, and salt marsh that improves the overall fish and wildlife habitat value of Run Pond.

- Minimize adverse impacts to natural, cultural, and socioeconomic resources.

Objectives

- Improve water quality within pond to restore aquatic habitat and reduce nuisance algal blooms. Key concerns are low dissolved oxygen and high nutrient levels during summer months.
- Increase salinity in emergent wetlands to restore saltmarsh vegetation.
- Eradicate *Phragmites*, an invasive emergent plant that threatens to displace *Spartina*, cattail, and other emergents.
- Maintain some permanent open water during low tide to provide a refuge for estuarine fish and invertebrates.
- Avoid long-term adverse impacts on a nearby town beach and parking area.
- Avoid increased flooding to structures near Run Pond.

INVENTORY OF EXISTING FISH AND WILDLFIE HABITAT

Existing habitat in the study area was mapped by Corps of Engineers biologists in the spring of 2003. The study area was defined as the maximum area affected by unrestricted tidal flow and adjacent wetland habitat. Habitat was classified based the USFWS system (Cowadin et. al., 1979). Emergent wetland was further classified by dominant plant species. Table 1 summarizes habitat occurring in the study area. Plants communities are further described in Section 2 of the main report. Vegetation Maps are included in the main report.

Table 1: Existing Fish and Wildlife Habitat in the Study Area

Habitat Type	Acres
Spartina and other saltmarsh grasses and herbs	2.3
Typha and Typha/Lythrum	4.7
Phragmites	2.8
Scrub/Shrub	9.9
Inertidal and Subtidal	10.6
Disturbed	0.2
Total	30.5

WITHOUT PROJECT CONDITION ANALYSIS

The guidance for performing incremental analysis requires a prediction of the Without Project Condition. The Without Project Condition (also known as No Action Alternative) describes expected the site conditions without a Federal project and are the basis for the evaluation of the action alternatives. Under the Without Project Condition, Run Pond habitat will continue to degrade because of limited tidal flushing and nutrient enrichment. Emergent marsh vegetation will continue to be dominated by freshwater and brackish water species, cattail, purple loosestrife, and *Phragmites*. *Phragmites* will become more prevalent, with an estimated rate of spread into adjacent wetland of 1 meter per year. Shoaling within the pond will further decrease tidal exchange. Filamentous algal blooms during summer months will become more frequent and more severe.

UNITS OF MEASUREMENTS AND MODELS

Benefits

Benefits were measured in habitat units (HUs) using USFWS Habitat Evaluation Procedures (HEP) models or other habitat models. The underlying assumption of the analysis is that the value of habitat for an organisms or a guild (a group of organisms that share a similar habitat and use resources in a similar manner) can be described by a Habitat Suitability Index (HSI) model. HSI models typically denote habitat suitability for a species as the relationship between two or more environmental variables that are deemed to affect the species' presence, distribution, and/or abundance. The HSI is defined as a value between 0.0 and 1.0, with 1.0 representing maximum habitat quality of a species in a defined area at a specific point in time, and is assumed to be positively correlated to habitat carrying capacity. The HSI value is multiplied by the area of available habitat (acres) to obtain HUs. For this study, average annual HUs were estimated over an expected 50 year project life.

Model Selection

Five ecological guilds were included in the habitat evaluation: benthic invertebrates, fish, waterfowl, tidal marsh birds, and birds which use scrub-shrub wetland habitat. Inclusion of these five guilds assures that all major habitat types affected by project alternatives are represented in the analysis.

For the Run Pond study, each guild was usually represented by a single species. Representative species are chosen based on the following considerations:

- occurrence in the study area
- availability of an appropriate habitat model
- availability and quality of data required for the habitat model
- ability to easily and reliably predict model parameters for all alternatives
- sensitivity of the habitat model to anticipated project impacts on habitat quality

A list of invertebrate, fish, and wildlife species likely to occur in the Run Pond study area was screened against a list of USFWS HEP models, Pennsylvania Modified HEP (PAMHEP) models, and habitat models available from other sources. Species occurring in Run Pond but lacking published habitat models were eliminated from consideration (e.g many invertebrates). Species for which Run Pond is provides only marginal habitat were also eliminated (e.g. winter flounder, great blue heron). The remaining species models were reviewed. Those that required collection of extensive field data, relied on parameters that were difficult to predict, or were insensitive to expected project impacts were not selected.

Models chosen for this study are summarized in Table 2. Softshell clam was selected to represent benthic invertebrates. Common mummichog was selected to represent the estuarine forage fish guild. Black duck was selected to represent the waterfowl guild. Yellow warbler was selected to represent songbirds that utilize scrub-shrub and scrub-shrub wetland habitat.

No single species model was appropriate to represent tidal marsh birds. This is because New England tidal marsh birds are a diverse assemblage of songbirds, wading birds, and shorebirds with divergent habitat requirements. Instead of using several single species models, a simple habitat suitability model for bird species diversity was developed from data collected by Benoit and Askins (1999). The model relates species richness of tidal marsh bird communities to vegetation type.

Table 2: Habitat Models Included in HEP Analysis.

Guild	Representative Species or Model	Reference	Habitat Type(s) Evaluated by Model			
			OW	**IT**	**EM**	**SS**
Benthic	Softshell Clam	Brown et al. 2000	X	X		
Fish	Common Mummichog	Brown et al. 2000	X	X		
Waterfowl	Wintering Black Duck	USFWS 1984	X	X	X	
Marsh Birds	Guild Model	This study			X	
Songbirds	Yellow Warbler	USFWS 1982				X

NOTE: OW = open water; IT – intertidal; EM= emergent marsh (wetland); SS = scrub/shrub

ENVIRONMENTAL PLAN INCREMENTS

The key restoration objectives are improved water quality, increased salinity in fringing vegetated wetlands, and eradication of *Phragmites* from the pond. Increased tidal flooding can achieve the first two objectives. Increased tidal flushing and spot herbicide application can achieve the final objective. Alternatives considered include no action and three alternatives that provide culverts or an open channel to increase tidal exchange. The alternatives are briefly described below.

<u>Alternative 1 - No Action Alternative</u>:

If no Federal action is taken, it is assumed that the site will remain degraded and that conditions will worsen over time. Given restricted tidal inflow, *Phragmites* will continue to spread and may eventually out-compete much of the remaining salt marsh vegetation. Water quality will continue to be poor due to limited tidal exchange. Low dissolved oxygen and dense algal mats will continue to severely degrade habitat quality.

<u>Alternative 2 - Install new 48-inch diameter culvert</u>.

This alternative installs a 48-inch diameter culvert to supplement flow through the existing 36-diameter culvert. The culvert will extend from a new headwall north of South Shore Drive through the town public parking area to the outlet at Bass River.

The alternative will increase the spring high tide range in the wetland by about a tenth of a foot from exiting conditions of 1.7 ft. NGVD to 1.8 feet NGVD. This would not be sufficient to restore fringing salt marsh vegetation around the pond. The ocean level is 2.0 feet NGVD, so the new 48-inch culvert will not completely eliminate the tidal restriction at the site. The new culvert will decrease the low tide range by about 1 foot and most of the pond would go dry during low tide. Tidal flushing would be greatly improved, with the time to fully exchange water within the pond decreasing from about 52 hours to 14 hours.

<u>Alternative 3- Install Two -5 ft. by 10 ft. box culverts:</u>

This alternative increases tidal flushing by installing two, 5'x10' reinforced concrete box culverts. The culverts would extend from a new headwall north of South Shore Drive through the town public parking area to the outlet at Bass River.

This alternative is expected to increase the spring tide water surface elevation to about 2.0 ft. NGVD. This duplicates ocean levels and should be sufficient to increase flooding and restore fringing salt marsh vegetation around the pond. The culverts will decrease the low tide range by about one foot and most of the pond would go dry during low tide. Tidal flushing would be greatly improved, with the time to fully exchange water within the pond decreasing from about 52 hours to 11 hours.

<u>Alternative 4. Box Culvert/Open Channel</u>

Under this alternative, two, 5'x10' reinforced concrete box culverts would be installed from a new inlet headwall north of South Shore Drive to an outlet headwall just west of South Shore Drive. A 20-foot-wide by 11-foot-deep (average) concrete "U" channel would extend from the outlet headwall to its terminus at Bass River, running along the northern edge of the parking lot.

This alternative would increase the spring tide water surface elevation to about 2.0 ft. NGVD. This duplicates ocean levels and should be sufficient to increase flooding and restore fringing saltmarsh vegetation around the pond. The culverts will decrease the low tide range by about one foot and most of the pond would go dry during low tide. Tidal flushing would be greatly improved, with the time to fully exchange water within the pond decreasing from about 52 hours to 12 hours.

Other Features Common to Alternatives 2, 3, and 4.

Alternatives 2, 3, and 4 include construction of an 0.4 acre shallow depression near Shore Drive at the southern end of the pond. The depression would provide a refuge for fish and other aquatic life during low tide when much of the pond will be dewatered. Material excavated from the depression will be used to construct a 0.3 acres wetlands at the southern end of the pond using material excavated from the depression. The constructed saltmarsh would compensate for vegetated wetland excavated to create an approach channel to the new culverts. Alternatives 2, 3 and 4 also include excavation of 11, 6 ft wide ditches within vegetated wetlands to improve tidal exchange and promote growth of salt marsh vegetation.

The alternatives include self-adjusting tide gates to control storm tide inflow and prevent any increased flooding of low-lying properties adjacent to the pond. The alternatives also include adjustable weirs to allow some surface to be retained within pond during low tide. Post construction adaptive management will determine how much surface water can be retained without sacrificing primary restoration objectives.

Improved tidal exchange provided by Alternatives 2, 3 and 4 will reduce the coverage of *Phragmites* but not completely eliminate it from the pond. The herbicide RODEO will be used to eradicate the remaining *Phragmites*.

HABITAT ANALYSIS

To apply the habitat models, a Corps of Engineers biologist predicted changes in cover type and habitat model parameters for each of the four alternatives. The predictions rely largely on hydraulic modeling of the Run Pond system (see Appendix A) and professional judgment.

Predicted Cover Types

Predicted cover types for each alternative are shown in the vegetation maps in the main report. Acreages are provided in Table 3. For Alternative 1 (No Action), sedimentation will cause shoaling but no significant loss of open water habitat. *Phragmites* acreage is expected to increase by 50 % (2 % per year), reducing the acreage of freshwater emergent wetland and saltmarsh. For Alternatives 2, 3, and 4, enhanced drainage will convert most of the existing subtital habitat to intertidal habitat.   Alternative 2 will increase tidal exchange and convert some fringing freshwater emergent marsh to saltmarsh.   Alternatives 3 and 4 will increase tidal range by 0.2 ft and convert additional freshwater emergent marsh to saltmarsh. Alternatives 3 and 4 will slow expansion of scrub-shrub vegetation into emergent wetland. Alternatives 2, 3, and 4 assume complete eradication of *Phragmites* can be achieved by a combination of increased flushing and application of a herbicide (RODEO).   Vegetation Maps displaying the habitat types for existing conditions and alternatives are included in the main report.

Table 3: Existing and Predicted Habitat Area

Habitat Type	**Alternative Acres (50 yr average Post Construction)**			
	Existing	**No Action**	**2**	**3 & 4**
Emergent Wetland				
Saltmarsh grasses and herbs	2.3	1.8	6	8.1
Typha	3.1	1.9	0.9	0.9
Typha/Lythrum	1.6	1.1	3.5	1.4
Phragmites	2.8	4	0	0
Scrub/Shrub	9.9	10.9	9.4	9.4
Intertidal and Subtidal	10.6	10.6	10.6	10.6
Disturbed	0.2	0.2	0.1	0.1
Total	30.5	30.5	30.5	30.5

Application of Habitat Models

Softshell Clam

Brown et al. (2000) provided suitability indices for adult/juvenile and spawning softshell clam. Habitat variables included depth, salinity, water temperature, and substrate.   For Run Pond, the SI for each habitat variable was predicted based on available information and professional judgment. The lowest (limiting) SI was designated as the HSI.

The HEP analysis for softshell clam is summarized in Tables 4 and 5.

For all alternatives the limiting habitat variable was temperature. Under existing conditions and the No Action Alternative, average midsummer water temperature was assumed to be > 24 ^{o}C, resulting in an SI of 0. For Alternatives 3 and 4, midsummer temperature was assumed to be between 20 – 22 ^{o}C, resulting in an SI of 0.5. Depth, salinity, and substrate were adequate to provide an SI of 1.0 for Alternatives 2, 3, and 4. For No Action, the SI for depth and substrate was 1.0, and for salinity was 0.5.

HUs were adjusted to account for the percent cover of algal mats. Algal mats can severely degrade clam habitat (see Frankenstein, 2000), and the habitat value for areas under algal mats was set at zero. Algal cover estimates were 50 % for existing conditions, 90% for the No Action Alternative, 10 % for Alternative 2, and 5% for Alternatives 3 and 4. Inclusion of a degradation factor for algal mats reduced habitat benefits from 5.0 to 4.7 HU for Alternatives 3 and 4 and from 5.0 to 4.5 HU for Alternative 2. The algal degradation factor is irrelevant for the No Action Alternative, because the HSI for this alternative was zero.

Table 4: Suitability Index Values for Soft-shell Clam.

Habitat Variable	Value	Suitability Index Adult - Juvenile	Spawning
Depth (m)	+1 - 0	1	1
	0 - 1	1	1
	1 - 2	0.5	0.5
Salinity (ppt)	15 - 20	0.5	0.5
	> 20	1	1
Temperature (^{O}C)	20-22	0.5	1
	22-24	0.1	0.5
	> 24	0	0
Substrate	Mud	1	1
	Sand	0.5	0.5
	Gravel	0.1	0.1

Run Pond Suitability Index Values

Variable	Existing Conditions	Suitability Index Alt 2 (no Action)	Alt 3	Alt 4
Depth	1	1	1	1
Salinity	1	1	1	1
Temperature	0	0	0.5 (A,J)	0.5 (A,J)
Substrate	1	1	1	1
Limiting SI	0	0	0.5	0.5

Table 5: Softshell Clam Habitat Units

Habitat Type	Existing Cond.			No Action			Alt 1			Alt 2 and 3		
	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU
Phragmites	2.8	0	0	4	0	0	0	0	0	0	0	0
Typha	3.1	0	0	1.9	0	0	0.9	0	0	0.9	0	0
Typha/Lythrum mix	1.6	0	0	1.1	0	0	3.5	0	0	1.4	0	0
disturbed area	0.2	0	0	0.2	0	0	0.1	0	0	0.1	0	0
open water or intertidal	10.6	0	0	10.6	0	0	9.9	0.5	4.5	9.9	0.5	4.7
salt marsh	2.3	0	0	1.8	0	0	6	0	0	8.1	0	0
shrub	9.9	0	0	10.9	0	0	9.4	0	0	9.4	0	0
new channel	0	-	-	0	-	-	0.3	0.5	0.14	0.3	0.5	0.14
new subtidal	0	-	-	0	-	-	0.4	0.5	0.18	0.4	0.5	0.19
TOTAL	30.5	-	0	30.5	-	0	30.5	-	4.74	30.5		5.03

<u>Common Mummichog</u>

Brown et al. (2000) provided suitability indices for common mummichog. Habitat variables included depth, salinity, water temperature, and substrate. For Run Pond, the SI for each habitat variable was predicted using available information and professional judgment. The lowest (limiting) SI was designated as the HSI.

The HEP analysis for mummichog is summarized in Tables 6 and 7.

Water temperature was assumed to be the limiting factor under existing conditions and the No Action Alternative. Shoaling expected under the No Action Alternative is expected to increase water temperature, lowering the HSI for eggs and larvae to 0.1 for Alternatives 2,3, and 4. Salinity was assumed to be between 25 – 30 ppt, limiting the SI to 0.5. Freshwater emergent marsh at Run Pond is infrequently flooded and was assumed to have no habitat value for mummichog. It was assumed that proposed channels and fringing habitat make ½ of the saltmasrh available to fish. It was also assumed that adequate refugia will exist at low tide to maintain a viable mummichog population. Dissolved oxygen is not included in the model, but could be an additional limiting factor under the No Action Alternative as the pond becomes more highly eutrophic and oxygen demand exerted by decomposing algal mats increases.

Table 6: Suitability Index Values for Common Mummichog.

Habitat Variable	Value	Suitability Index Adult - Juvenile	Larvae Egg
Depth (m)			
	+1 - 2	1	1
	+1 - 0	1	0.5
	0 - 1	1	0
	1 - 2	0.5	0
Salinity (ppt)			
	20 - 25	1	1
	25 - 30	0.5	0.5
	> 30	0.1	0.1
Temperature (^{O}C)			
	16 - 26	1	1
	26 - 28	0.5	0.5
	28 - 30	0.5	0.1
	30 - 32	0.1	0
Substrate			
	Mud	1	0.5
	Sand	0.1	0.1
	Vegetatior	1	1

Run Pond Suitability Index Values

Variable	Salt Mars Index				Open Water/Inertidal Index			
	Existing Conditions	Alt 2 (no Action)	Alt 3	Alt 4	Existing Conditions	Alt 2 (no Action)	Alt 3	Alt 4
Depth	1	1	1	1	1	1	1	1
Salinity	1	1	1	1	0.5	0.5	1	1
Temperature	0.5	0.5	1	1	0.5	0.1 (J)	0.5	0.5
Substrate	1	1	1	1	0.5 (J)	0.5 (J)	0.5 (J)	0.5 (J)
Limiting SI	0.5	0.5	1	1	0.5	0.1	0.5	0.5

Table 7: Common Mummichog Habitat Units

Habitat Type	Existing Condition			No Action			Alt 2			Alt 3/4		
	Acres	**HSI**	**HU**	**Acres**	**HSI**	**HU**	**Acres**	**HSI**	**HU**	**Acres**	**HSI**	**HU**
Phragmites	2.8	0	0	4	0	0	0	0	0	0	0	0
Typha	3.1	0	0	1.9	0	0	0.9	0	0	0.9	0	0
Typha/Lythrum mix	1.6	0	0	1.1	0	0	3.5	0	0	1.4	0	0
disturbed area	0.2	0	0	0.2	0	0	0.1	0	0	0.1	0	0
open water or inertial	10.6	0.5	5.3	10.6	0.1	1.06	9.9	0.5	4.5	9.9	0.5	4.7
salt marsh	2.3	0.5	0.58	1.8	0.5	0.9	6	1	3	8.1	1	4.05
shrub	9.9	0	0	10.9	0	0	9.4	0	0	9.4	0	0
new channel	0	-	-	0	-	-	0.3	0.5	0.14	0.3	0.5	0.14
new sub tidal	0	-	-	0	-	-	0.4	0.5	0.18	0.4	0.5	0.19
TOTAL	30.5	-	5.88	30.50	-	1.96	30.5	-	7.82	30.5		9.08

Wintering Black Duck

The black duck model was applied separately for open water and emergent wetland habitats as recommended in the model documentation (USFWS, 1984).

The model for emergent open water habitat south of Cape Cod is given as:

$$HSI = \{[(SI_{VI} + SI_{V2})/2]^2 \times [(SI_{V3} + SI_{V4})/2]\}^{1/3}$$

The model for emergent wetland is:

$HSI = [(2 \times SI_{V5}) + SI_{V6} + SI_{V7}]/4$

where:

SI_{V1} = percentage of sub tidal open water <1 m deep at low tide.
SI_{V2} = percentage of total open-water area that becomes exposed at low tide
SI_{V3} = percentage of sub tidal open water that supports rooted vascular aquatic plants
SI_{V4} = percentage of area of tidal flats that have $\geq$ 300 clams/m^2
SI_{V5} = percentage of emergent and forested wetland occupied by creeks, ponds, and impoundments
SI_{V6} = percentage of substrate from ponds or impoundments occupied by *Ruppia* or *Potamogeton*
SI_{V7} = percentage of emergent marsh that supports $\geq$ 750 snails/m^2

Of other wetland cover types at Run Pond, only open water and saltmarsh are assumed to provide significant habitat for black duck. Calculation of HSIs for these habitat types is described below and summarized in Table 8.

Open Water: For all alternatives the percentage of open water habitat < 1 meter deep at MLW is assumed to be 100%, resulting in an SI for variable 1 of 0.6. No significant mudflat is present under Alternative 1, resulting in a SI of 0.0 for variable 2. Alternatives 2, 3, and 4 will largely drain the pond during each tidal cycle, resulting in extensive mudflats and an estimated SI of 0.7 for variable 2. Variable 3 required an estimate of the area occupied by rooted vascular plants (e.g. eelgrass). The suitability index for this variable levels off at 1.0 when the percent cover of vegetation reaches 20 percent. Under Alternative 1 (No Action), the SI for variable 3 is zero because algal mats will suppress the growth of submerged vascular plants. Improved tidal exchange is expected to largely eliminate algal mats. Percent cover of submerged vegetation under Alternatives 2, 3, and 4 is estimated at 10%. For Alternative 1 (No Action), the SI for variable 3 is zero since softshell clam density is suppressed by algal mats. Improved tidal exchange is expected to provide greatly improved softshell clam habitat, resulting in an SI of 1.0 for variable 4.

Saltmarsh: Variable 5 represents the percentage of salt marsh occupied by creeks, ponds, and impoundments. For alternative 1, the saltmarsh is devoid of creeks and ponds (pools) and the SI is 0.0. Creation of inlets and pools within saltmarsh under Alternatives 2, 3, and 4, increases the SI for variable 5 to 0.4 for these alternatives. Variable 6 requires an estimate of the area of ponds on the marsh portion of the site occupied by the rooted vascular plants. Under Alternative 1 there are no ponds, resulting in an SI of 0.0. For the other alternatives, percent cover of vegetation within ponds (shallow pools) is estimated at 20 %, resulting in an SI of 0.2. Variable 7 concerns the percentage of the emergent marsh that supports snails at greater than 750 per square meter. The suitability index for this variable levels off at 1 when the percentage of the area with snails at this density reaches 25. Snail density is assumed to be a function of periphyton growth, which is a function of tidal flushing. Under the No Action Alternative, tidal flushing is absent and snail density is expected to be low, resulting in an SI of 0.0 for variable 7. Increase tidal flushing under the other alternatives should increase snail density near tidal creeks and pools, resulting in an SI of ranging from 0.2 to 0.7.

HUs for wintering black duck are provided in Table 9.

Table 8: Wintering Black Duck HSIs

Alternative	**% Subtidal Open Water ≤ 1 m Deep at MLW**	**SI (V_1)**	**% Mudflat**	**SI (V_2)**	**Estimated % Subtidal w/Plants**	**SI (V_3)**	**% Mudflats w/≥ 300 clams/ m^2**	**SI (V_4)**	**HSI Open Water**
Existing	100	0.6	0	0.0	0	0.0	10	0.25	0.22
1	100	0.6	0	0.0	0	0.0	5	0.05	0.13
2	100	0.6	90	0.7	10	0.4	> 25	1.0	0.67
3	100	0.6	90	0.7	10	0.4	>25	1.0	0.67
4	100	0.6	90	0.7	10	0.4	>25	1.0	0.67

Alternative	**% Estuarine Emergent w/ Ponds and Creeks**	**SI (V_5)**	**Estimated % Substrate w/ Pondweed**	**SI (V_6)**	**Estimated % Emergent Marsh w/Snails**	**SI (V_7)**	**HSI Marsh**
Existing	0	0.0	0	0.0	0	0.0	0.0
1	0	0.0	0	0.0	0	0.0	0.0
2	10	0.4	20	0.2	20	0.2	0.30
3	10	0.4	20	0.2	20	0.7	0.43
4	10	0.4	20	0.2	20	0.7	0.43

Table 9: Wintering Black Duck Habitat Units

Habitat Type	Existing Condition			No Action			Alt 2			Alt 3/4		
	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU
Phragmites	2.8	0	0	4	0	0	0	0	0	0	0	0
Typha	3.1	0	0	1.9	0	0	0.9	0	0	0.9	0	0
Typha/Lythrum m	1.6	0	0	1.1	0	0	3.5	0	0	1.4	0	0
disturbed area	0.2	0	0	0.2	0	0	0.1	0	0	0.1	0	0
open water or inte	10.6	0.22	2.3	10.6	0.13	1.4	9.9	0.67	6.63	9.9	0.67	6.63
saltmarsh	2.3	0	0	1.8	0	0	6	0.3	1.8	8.1	0.43	3.48
shrub	9.9	0	0	10.9	0	0	9.4	0	0	9.4	0	0
new channel	0	-	-	0	-	-	0.3	0	0	0.3	0	0
new subtidal	0	-	-	0	-	-	0.4	0	0	0.4	0	0
TOTAL	30.5	-	2.3	30.5	-	1.4	30.5	-	8.4	30.5		10.1

Tidal Marsh Birds

Benoit and Askins (1999) studied the relationship between bird community diversity and vegetation community type in salt and brackish water marshes in Connecticut.

Plant communities were classified into one of 6 categories:

Category	Description
Short Grass Meadow	At least 50% combined cover *of Juncus gerardi*, *Distichlis spicata*, *Spartina patens*, and *S. alterniflora*, with *S. alterniflora* < 50 % cover.
Phragmites	$\geq$ 50 % cover of *Phragmites*
Cattail	$\geq$ 30 % cover of cattail and < 30 % any other plant species
Short *Spartina alterniflora*	> 50 % *S. alterniflora* that is less than 50 cm tall.
Brackish Mixture	Small areas of short graminoids surrounded by taller emergents where each taxon represented less than 50 % cover
Other	Not meeting any of the above criteria.

Bird community data reported included the mean number of species observed for each vegetation category:

Category	Mean Number of Bird Species
Short Grass Meadow	5.00
Phragmites	3.64
Cattail	4.14
Short *Spartina alterniflora*	5.19
Brackish Mixture	5.00
Other	4.00

The mean number of bird species observed in short grass meadow and brackish mixture habitat was significantly higher ($p = 0.029$) than the number observed in Phragmites. A bird survey in a salt marsh in Gallilee, Rhode Island found similar numbers of species, with 33 species occurring in predominantly *Phragmites* marsh prior to restoration to salt marsh versus 38 species following restoration (Myshrall, 2000).

Based on the Benoit and Askins study, the habitat suitability index for bird species community richness was normalized to 1.0 for short grass meadow and brackish mixture habitat proportionally for *Phragmites* and cattail habitat:

Table 10. HSI Marsh Birds

Habitat Type	Mean Number of Bird Species	HSI
Shortgrass meadow	5.00	1.00
Phragmites	3.64	0.73
Typha	4.14	0.83
Brackish Mixture	5.00	1.00

These HSI's were adopted for Run Pond, with saltmarsh given a 1.00, *Phragmites* 0.73, and *Typha* and *Typha/Lythrum* 0.83. HUs are provided in Table 10.

Table 11. Marsh Bird Habitat Units

Habitat Type	Existing Condition			No Action			Alt 2			Alt 3/4		
	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU
Phragmites	2.8	0.7	1.96	4	0.7	2.8	0	0.7	0	0	0.7	0
Typha	3.1	0.8	2.48	1.9	0.8	1.52	0.9	0.8	0.72	0.9	0.8	0.72
Typha/Lythrum mix	1.6	0.8	1.28	1.1	0.8	0.88	3.5	0.8	2.8	1.4	0.8	1.12
disturbed area	0.2	0	0	0.2	0	0	0.1	0	0	0.1	0	0
open water or intertidal	10.6	0	0	10.6	0	0	9.9	0	0	9.9	0	0
salt marsh	2.3	1	2.3	1.8	1	1.8	6	1	6	8.1	1	8.1
shrub	9.9	0	0	10.9	0	0	9.4	0	0	9.4	0	0
new channel	0	-	-	0	-	-	0.3	0	0	0.3	0	0
new subtidal	0	-	-	0	-	-	0.4	0	0	0.4	0	0
TOTAL	30.5	-	8.02	30.5	-	7	30.5	-	9.52	30.5		9.94

Yellow Warbler

The yellow warbler model (USFWS, 1982) was used to model songbird utilization of scrub-shrub habitat.

Model: $HSI = (VI \times V2 \times V3)^{1/2}$

where:

V1 = percent deciduous shrub crown cover
V2 = average height of deciduous shrub canopy
V3 = percent of deciduous shrub canopy comprised of hydrophytic shrubs

Increased tidal flushing resulting from Alternatives 2, 3, and 4 was assumed to reduce expansion of scrub-shrub habitat (see Table 3). Within scrub-shrub habitat, however, the predicted HSIs for yellow warbler were identical for all alternatives (Table 12). HUs are provided in Table 13.

Table 12: Yellow Warbler HSI's.

Alternative	**% Deciduous shrub crown cover**	**SI (V_1)**	**Average height of shrub canopy (m)**	**SI (V_2)**	**% of canopy hydrophytic shrubs**	**SI (V_3)**	**HSI**
Existing	0	0.0	0	0.0	0	0.0	0.89
1	0	0.0	0	0.0	0	0.0	0.89
2	10	0.4	20	0.2	20	0.7	0.89
3	10	0.4	20	0.2	20	0.7	0.89
4	10	0.4	20	0.2	20	0.7	0.89

Table 13: Yellow Warbler Habitat Units

Habitat Type	Existing Condition			No Action			Alt 2			Alt 3/4		
	Acres	**HSI**	**HU**	**Acres**	**HSI**	**HU**	**Acres**	**HSI**	**HU**	**Acres**	**HSI**	**HU**
Phragmites	2.8	0	0	4	0	0	0	0	0	0	0	0
Typha	3.1	0	0	1.9	0	0	0.9	0	0	0.9	0	0
Typha/Lythrum mix	1.6	0	0	1.1	0	0	3.5	0	0	1.4	0	0
disturbed area	0.2	0	0	0.2	0	0	0.1	0	0	0.1	0	0
open water or intertidal	10.6	0	0	10.6	0	0	9.9	0	0.00	9.9	0	0.00
salt marsh	2.3	0	0	1.8	0	0	6	0	0	8.1	0	0.00
shrub	9.9	0.78	7.72	10.9	0.89	9.70	9.4	0.89	8.366	9.4	0.9	8.46
new channel	0	-	-	0	-	-	0.3	0	0	0.3	0	0
new subtidal	0	-	-	0	-	-	0.4	0	0	0.4	0	0
TOTAL	30.5	-	7.72	30.5	-	9.70	30.5	-	8.37	30.5		8.46

Table 14: Run Pond HEP- Summary Table

Species/Guild	Habitat Units				
	Existing	No Action (25 YR AVER)	Alt 2	Alt 3	Alt 4
Softshell Clam	0	0	4.74	5.03	5.03
Common Mummichog	5.88	1.96	7.82	9.08	9.08
Marsh Birds	8.02	7	9.52	9.94	9.94
Black Duck	1.7	1.35	8.46	10.04	10.04
Yellow Warbler	7.72	9.7	8.37	8.46	8.46
Total Habitat Units	23.32	20.01	38.91	42.55	42.55
Total Habitat Units Rounded		**20**	**38.9**	**42.6**	**42.6**

SUMMARY Of RESULTS

The HUs provided for each of the alternatives are summarized in Table 13 above. Alternative 2 yields 18.9 HUs relative to the No Action Alternative. Alternatives 3 and 4 yield 22.6 HUs relative to No Action. The habitat information presented in this appendix is utilized in the Cost Effective/Incremental Analysis and used to determine the alternative that best reasonably maximizes environmental benefits.

REFERENCES

Benoit, L.K. and R.A. Askins. 1999. Impact of the spread of *Phragmites* on the distribution of birds in Connecticut tidal marshes. Wetlands 19: 194-208.

Brown, S.K., K.R. Buja, S.H. Jury, M.E., Monaco, and A. Banner. 2000. Habitat suitability index
models for eight fish and invertebrate species in Casco and Sheepscot Bays, Maine. North American Journal of Fisheries Management 20: 408-435.

Cowardin, L.M, V. Carter, F. C. Golet, and E.T. LaRoe, 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. Office of Biological Services Washington, D.C.

Lewis, J.C. and R.L. Garrison. 1984. Habitat suitability index models: American black duck (wintering). US Fish and Wildlife Service Biological Report 82 (10.91). 15 pp.

Myshrall, DHA, Golet, FC, Paton, PWC, and Tefft, BC, 2000. *Salt Marsh Restoration Monitoring at the Galilee Bird Sanctuary, Narragansett, Rhode Island.* Rhode Island Department of Environmental Management, Division of Fish and Wildlife, Final Report

Schroeder, R.L. 1982. Habitat suitability index models: Yellow warbler. US Fish and Wildlife Service Biological Report 82 (10.27). 8 pp.

APPENDIX D. COSTS

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Runs Pond Marsh Restoration
LOCATION: Yarmouth, Massachusetts

DISTRICT: New England District PREPARED: 5-Jun-08
POC: Christoher J. Lindsay, Chief, Cost Engineering

This Estimate reflects the scope and schedule in feasibility report; Runs Pond Feasibilty Report

	Estimate Prepared: 8-Feb-08 / Effective Price Level: 2-Nov-07					Program Year (Budget EC): 2010 / Effective Price Level Date: 1 OCT 10				FULLY FUNDED PROJECT ESTIMATE			
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1 OCT 10 ($K)	COST ($K)	CNTG ($K)	FULL ($K)
06	FISH & WILDLIFE FACILITIES	2,455	491	20%	2,946	2.1%	2,506	501	3,007	-	2,573	514	3,087
	CONSTRUCTION ESTIMATE TOTALS:	2,455	491		**2,946**		2,506	501	3,007		2,573	514	3,087
01	LANDS AND DAMAGES	164	41		205		167	42	209	-	171	43	214
21	RECONNAISSANCE STUDIES			-	-				-	-			-
22	FEASIBILITY STUDIES									310			310
30	PLANNING, ENGINEERING & DESIGN	310	62	20%	372		316	63	379	-	318	63	381
31	CONSTRUCTION MANAGEMENT	150	30	20%	180		154	30	184	-	158	30	188
	PROJECT COST TOTALS:	3,079	624	20%	**3,703**		3,143	636	3,779	310	3,220	650	**4,180**

ESTIMATED FEDERAL COST: **2,717**
ESTIMATED NON-FEDERAL COST: **1,463**

ESTIMATED TOTAL PROJECT COST: 4,180

______________________ CHIEF, COST ENGINEERING, Christopher Lindsay

______________________ Project Management, Barbara Blumeris

______________________ CHIEF, REAL ESTATE, Joseph Redlinger

______________________ CHIEF, PLANNING, John Kennelly

______________________ CHIEF, ENGINEERING, H. Farrell McMillan

______________________ CHIEF, OPERATIONS, Richard Carlson

______________________ CHIEF, CONSTRUCTION, Richard Carlson

______________________ CHIEF, CONTRACTING, Sheila Winston

______________________ CHIEF, PM-PB, William Scully

______________________ CHIEF, DPM,

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Runs Pond Marsh Restoration
LOCATION: Yarmouth, Massachusetts
This Estimate reflects the scope and schedule in feasibility report; Runs Pond Feasibilty Report

DISTRICT: New England District PREPARED: 5-Jun-08
POC: Christoher J. Lindsay, Chief, Cost Engineering

	Estimate Prepared: 2007(Oct - Dec) Effective Price Level: 2008(Oct - Dec)					Program Year (Budget EC): 2010 Effective Price Level Date: 1 OCT 10				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #1 - xxx													
06	FISH & WILDLIFE FACILITIES	2,455	491	20%	2,946	2.1%	2,506	501	3,007	2010Q2	2.7%	2,573	514	3,087
	CONSTRUCTION ESTIMATE TOTALS:	2,455	491	20%	**2,946**		2,506	501	3,007			2,573	514	3,087
01	LANDS AND DAMAGES	164	41	25%	205	2.1%	167	42	209	2010Q2	2.7%	171	43	214
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.8%	Project Management	45	9	20%	54	2.1%	46	9	55	2009Q1		46	9	55
0.8%	Planning & Environmental Compliance	20	4	20%	24	2.1%	20	4	24	2009Q1		20	4	24
6.9%	Engineering & Design,VE, ITR, Contractin	170	34	20%	204	2.1%	174	35	209	2009Q1		174	35	209
2.4%	Engineering/Planning During Construction	60	12	20%	72	2.1%	61	12	73	2010Q2	2.7%	63	12	75
0.6%	Project Operation: O&M Manual	15	3	20%	18	2.1%	15	3	18	2009Q1		15	3	18
31	CONSTRUCTION MANAGEMENT													
3.3%	Construction Management	80	16	20%	96	2.1%	82	16	98	2010Q2	2.7%	84	16	100
1.2%	Project Operation: Monitoring	30	6	20%	36	2.1%	31	6	37	2010Q2	2.7%	32	6	38
1.6%	Project Management	40	8	20%	48	2.1%	41	8	49	2010Q2	2.7%	42	8	50
	CONTRACT COST TOTALS:	3,079	624		**3,703**		3,143	636	3,779			3,220	650	**3,870**

Run Pond Alt 2 48" Culvert
Remove some existng drainage
piping and install new 48" RCP,
36"RCP and automatic tide gates

Designed By: CENAE
Estimated By: CENAE-E/P-MR

Prepared By: CENAE-E/P-Cost Engineering

Preparation Date: 01/19/05
Effective Date of Pricing: 11/06/07
Est Construction Time: 365 Days

Sales Tax: 0.0%

Remove some existing tide water drainage pipes and install new 36"RCP and supplemental 48"RCP to improve tidal drainage. New outlets shall have a headwall and automatic tide gates. The temporary earth support system will consist of steel sheet piles and dewatering well points. Also, excavate 741CY from area in pond to create fish habitat, and install adjustable stoplogs at each culvert headwall. The site is easily accessible from South Shore Drive. The following are the markups used: home office OH 6%, field office OH 10%, profit 10% and 1.5% bond. Contingency factor used is 15% because this is feasibility level estimate and there are no construction specifications or detailed plans at this time.

6 NOV 2007 - Updated

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
I5	Mob and Demob	1.00		16,893	2,534	0	19,427	19427
IA	Demolition and Utilities	1.00		87,758	13,164	0	100,922	100922
IF	Earthwork	1.00		174,887	26,233	0	201,120	201120
IK	Water and Earth Control	1.00		1,925,399	288,810	0	2,214,209	2214209
IP	Sitework and Traffic Control	1.00		168,735	25,310	0	194,045	194045
IU	Excavate Pond/Create Fish Hole	1.00		81,819	12,273	0	94,092	94092
TOTAL	Run Pond Alt 2 48" Culvert	1.00	EA	2,455,491	368,324	0	2,823,815	2823815

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
I5	Mob and Demob							
I5.18	Mobilization and Setup at Site	1.00		12,598	1,890	0	14,487	14487
I5.23	Demobilize and Return Equipment	1.00		4,296	644	0	4,940	4939.96
	TOTAL Mob and Demob	1.00		16,893	2,534	0	19,427	19427
IA	Demolition and Utilities							
IA.39	Remove exist. 48" RCP	1.00		6,766	1,015	0	7,781	7780.50
IA.44	Pipe Removal and Disposal	1.00		31,946	4,792	0	36,737	36737
IA.49	Manhole Removal and Disposal	1.00		939	141	0	1,080	1080.42
IA.54	R/D and haul up to 5 miles	1.00		43,657	6,549	0	50,206	50206
IA.59	Utilitu Removal /Relocation	1.00		4,450	668	0	5,118	5117.74
	TOTAL Demolition and Utilities	1.00		87,758	13,164	0	100,922	100922
IF	Earthwork							
IF.19	Earth Excavation	1.00		22,158	3,324	0	25,482	25482
IF.24	Backfill reuse existing	1.00		3,558	534	0	4,092	4091.71
IF.29	Addtional Backfill	1.00		2,341	351	0	2,693	2692.67
IF.34	Compaction of fill materials	1.00		5,793	869	0	6,662	6661.96
IF.94	Channel Excavation	1.00		4,690	703	0	5,393	5393.37
IF.9E	Excavation with trench box	1.00		16,130	2,419	0	18,549	18549
IF.9J	Stone Bedding	1.00		7,657	1,149	0	8,805	8805.37
IF.GR	Granular Fill incl.compaction	1.00		112,560	16,884	0	129,444	129444
	TOTAL Earthwork	1.00		174,887	26,233	0	201,120	201120
IK	Water and Earth Control							
IK. N	New Cofferdam at Wall & Sump Loc	1.00		112,780	16,917	0	129,697	129697
IK.89	Well Points	1.00		314,359	47,154	0	361,513	361513
IK.GW	New 48" RCP	1.00		195,820	29,373	0	225,194	225194
IK.H1	New 36" RCP	1.00		39,128	5,869	0	44,997	44997
IK.H6	New RC Manholes 12' deep	1.00		28,263	4,239	0	32,503	32503
IK.HG	New RC Headwalls-2 ea	1.00		66,870	10,031	0	76,901	76901
IK.HL	New 5'x5' Trash Racks	1.00		14,634	2,195	0	16,830	16830
IK.HQ	New 36" gates	1.00		48,902	7,335	0	56,238	56238
IK.HV	New 48" Tide Gates	1.00		55,412	8,312	0	63,723	63723
IK.I0	Temporary Earth Support System	1.00		1,049,230	157,384	0	1,206,614	1206614
	TOTAL Water and Earth Control	1.00		1,925,399	288,810	0	2,214,209	2214209
IP	Sitework and Traffic Control							

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
IP.64 Barricades	1.00		6,208	931	0	7,139	7139.28
IP.69 Additional Barriers	1.00		16,084	2,413	0	18,497	18497
IP.74 Signage	1.00		1,820	273	0	2,093	2092.97
IP.79 Police Detail	1.00		40,402	6,060	0	46,462	46462
IP.84 Erosion Control	1.00		5,143	772	0	5,915	5914.86
IP.HB New Bituminous Conc. Pavement	1.00		99,077	14,862	0	113,939	113939
TOTAL Sitework and Traffic Control	1.00		168,735	25,310	0	194,045	194045
IU Excavate Pond/Create Fish Hole							
IU. 5 Culvert Stoplogs in Pond	1.00	EA	10,896	1,634	0	12,530	12530
IU.10 Excavate Sediment	1.00	EA	25,285	3,793	0	29,077	29077
IU.15 Place Sediment on Bank	1.00	EA	4,681	702	0	5,384	5383.56
IU.20 Remove Temporary Road	1.00	EA	5,638	846	0	6,483	6483.16
IU.25 Remove Fragmites	1.00	EA	2,685	403	0	3,088	3087.62
IU.30 Seeding	1.00	EA	4,610	692	0	5,302	5301.85
IU.35 Mob and Demob	1.00	EA	18,261	2,739	0	21,000	21000
IU.45 Construct Temporary Road	1.00	EA	9,764	1,465	0	11,228	11228
TOTAL Excavate Pond/Create Fish Hole	1.00		81,819	12,273	0	94,092	94092
TOTAL Run Pond Alt 2 48" Culvert	1.00	EA	2,455,491	368,324	0	2,823,815	2823815

DETAILED ESTIMATE — DETAIL PAGE

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

I5.18. Mobilization and Setup at Site	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
AF 1 <01594 1400 > Toilet, portable chemical, rent per month 2ea for 6 mon use 12	12.00 MO	0.00 0	0.00 0	80.17 962	0.00 0	80.17 962	80.17
AF 1 <01594 0350 > Office trailer, rent per month, furnished, no hookups, 32' x 8'	12.00 MO	0.00 0	0.00 0	165.00 1,980	0.00 0	165.00 1,980	165.00
USR 1 <01594 0300 > mobilize and deliver equipment	6.00 EA	1072.45 6,435	0.00 0	50.00 300	0.00 0	1122.45 6,735	1122.45
TOTAL Mobilization and Setup at Site	1.00	6,435	0	3,242	0	9,677	9676.73
B RSM 1 <01594 0300 > Demobilize and Deliver Equipment and Materials	6.00 EA	499.94 3,000	0.00 0	50.00 300	0.00 0	549.94 3,300	549.94
TOTAL Demobilize and Return Equipment	1.00	3,000	0	300	0	3,300	3299.66
TOTAL Mobilization and Setup at Site	1.00	0	0	0	0	0	0.00
TOTAL Mobilization and Setup at Site	1.00	0	0	0	0	0	0.00
TOTAL Mob and Demob	1.00	9,434	0	3,542	0	12,976	12976
B MIL 1 <02752 4500 > removal and disposal of 48"RCP	1.00 EA	4683.92 4,684	513.08 513	0.00 0	0.00 0	5197.00 5,197	5197.00
TOTAL Remove exist. 48" RCP	1.00	4,684	513	0	0	5,197	5197.00
L CIV 1 <02046 3000 > Site dml, pipe removal, 36" dia, conc, water/sewer, no excavation	300.00 LF	64.71 19,412	7.09 2,126	0.00 0	10.00 3,000	81.80 24,539	81.80
TOTAL Pipe Removal and Disposal	1.00	19,412	2,126	0	3,000	24,539	24539
B HTW 1 <02086 5741 > Manhole removal and disposal	1.00 EA	600.61 601	121.06 121	0.00 0	0.00 0	721.67 722	721.67
TOTAL Manhole Removal and Disposal	1.00	601	121	0	0	722	721.67
MIL 1 <02049 0605 > Remove and dispose of bituminous conc. paving	6300.00 CF	3.50 22,064	1.02 6,453	0.00 0	0.50 3,150	5.03 31,667	5.03
L AF 1 <02234 4000 > Hauling bituminous conc. pavement	233.00 CY	3.77 878	4.25 990	0.00 0	0.00 0	8.01 1,867	8.01

IA.54. R/D and haul up to 5 miles	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
TOTAL R/D and haul up to 5 miles	1.00	22,942	7,443	0	3,150	33,535	33535
MIL 1 <02658 3000 > Piping, water dist, 12" dia, 150		16.00	4.81	44.13	0.00	64.94	
PSI, CCP, 40' L	20.00 LF	320	96	883	0	1,299	64.94
L MIL 1 <02662 3020 > Piping, water dist, 2" dia, 20'		30.65	0.00	4.31	0.00	34.96	
joints, copper, tubing, type K	20.00 LF	613	0	86	0	699	34.96
B MIL 1 <02667 4060 > Piping, water dist, 8", PVC,		51.02	0.00	20.00	0.00	71.02	
press pipe, class 200, SDR 21	20.00 LF	1,020	0	400	0	1,420	71.02
TOTAL Utilitu Removal /Relocation	1.00	1,953	96	1,369	0	3,418	3418.40
TOTAL Demolition and Utilities	1.00	49,593	10,299	1,369	6,150	67,411	67411
L MIL 1 <02228 0322 > Excavate trench, mdm soil, 1 CY		11.19	5.54	0.00	1.00	17.73	
excavator	960.00 CY	10,744	5,317	0	960	17,021	17.73
TOTAL Earth Excavation	1.00	10,744	5,317	0	960	17,021	17021
M MIL 1 <02215 2460 > Backfill, reuse existing,		1.89	0.95	0.00	0.00	2.85	
front-end loader, 1.5 CY	960.00 CY	1,817	916	0	0	2,733	2.85
TOTAL Backfill reuse existing	1.00	1,817	916	0	0	2,733	2733.06
M MIL 1 <02215 2460 > Backfill, sand bedding trenches,		1.89	0.95	10.00	0.00	12.85	
front-end loader, 1.5 CY	140.00 CY	265	134	1,400	0	1,799	12.85
TOTAL Addtional Backfill	1.00	265	134	1,400	0	1,799	1798.57
MIL 1 <02220 6400 > Compaction, 1 ton roller, around		3.60	0.45	0.00	0.00	4.05	
structures & trenches	1100.00 CY	3,956	493	0	0	4,450	4.05
TOTAL Compaction of fill materials	1.00	3,956	493	0	0	4,450	4449.86
L MIL 1 <02228 0320 > channel excavation, includes		17.41	8.61	0.00	4.00	30.02	
dewatering and hauling	120.00 CY	2,089	1,034	0	480	3,603	30.02
TOTAL Channel Excavation	1.00	2,089	1,034	0	480	3,603	3602.51
L CIV 1 <02228 3120 > Excavate trench, with trench		2.00	3.90	0.00	0.00	5.90	
box, 10' x 20'	2100.00 CY	4,200	8,190	0	0	12,390	5.90

IF.9E. Excavation with trench box	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
TOTAL Excavation with trench box	1.00	4,200	8,190	0	0	12,390	12390
MIL 1 <02244 0100 > Base course, crushed 3/4" stone, compacted, 6"D, large areas		0.48	0.40	4.03	0.00	4.90	
	1200.00 SY	571	474	4,836	0	5,882	4.90
TOTAL Stone Bedding	1.00	571	474	4,836	0	5,882	5881.56
L MIL 1 <02216 5530 > Granular fill w. compaction, 3 cy loader foundation		19.16	9.66	0.00	0.00	28.82	
	3000.00 CY	57,491	28,971	0	0	86,463	28.82
TOTAL Granular Fill incl.compaction	1.00	57,491	28,971	0	0	86,463	86463
TOTAL Earthwork	1.00	81,134	45,529	6,236	1,440	134,339	134339
B MIL 1 <02161 0400 > Sheet piling, stl, 32' exc,38 PSF,drive,extrct&salvage, no wales		404.81	140.91	1190.00	0.00	1735.72	
	48.00 TON	19,431	6,764	57,120	0	83,314	1735.72
MIL 1 <02161 2550 > Sstl, connections & struts for sheet piles 2/3 salvage, wales		2368.79	761.21	186.83	0.00	3316.83	
	1.00 TON	2,369	761	187	0	3,317	3316.83
TOTAL New Cofferdam at Wall & Sump Loc	1.00	21,799	7,525	57,307	0	86,631	86631
B RSM 1 <02144 1000 > +Wellpoints, 200' L header, 8" dia -		282.46	0.00	120.00	0.00	402.46	
	600.00 LF	169,473	0	72,000	0	241,473	402.46
TOTAL Well Points	1.00	169,473	0	72,000	0	241,473	241473
M MIL 1 <02762 2090 > Piping, drainage & sewage, 48" dia, RCP, class 3, no gaskets		63.34	19.03	75.00	0.00	157.37	
	920.00 LF	58,277	17,508	69,000	0	144,784	157.37
MIL 1 <03356 0410 > Grout, non-metallic, non-shrink, joint, 1/2" x 6" wide- for joints in 48" concrete drainage pipe		1.22	0.10	0.10	0.00	1.42	
	1350.00 LF	1,646	135	135	0	1,916	1.42
CIV 1 <02250 2140 > Geotextile fabric, 120 mil thick, non-woven polypropylene		1.03	0.15	1.29	0.00	2.48	
	1500.00 SY	1,551	231	1,935	0	3,718	2.48
TOTAL New 48" RCP	1.00	61,474	17,875	71,070	0	150,418	150418
MIL 1 <02762 2060 > Piping, drainage & sewage, 36" dia, RCP, class 3, no gaskets		42.23	12.69	35.03	0.00	89.95	
	315.00 LF	13,302	3,996	11,034	0	28,333	89.95

IK.H1. New 36" RCP			QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
MIL 1	<03356 0410 >	Grout, non-metallic, non-shrink, joint, 1/2" x 6" wide	400.00 LF	1.22 488	0.10 40	0.10 40	0.00 0	1.42 568	1.42
CIV 1	<02250 2140 >	Geotextile fabric, 120 mil thick, non-woven polypropylene- for joints in 36" concrete drainage pipe	466.00 SY	1.03 482	0.15 72	1.29 601	0.00 0	2.48 1,155	2.48
		TOTAL New 36" RCP	1.00	14,272	4,108	11,676	0	30,056	30056
B MIL 1	<16711 1900 >	Drainage, sewer 12' deep, manhole	4.00 EA	1866.72 7,467	560.81 2,243	3000.00 12,000	0.00 0	5427.53 21,710	5427.53
		TOTAL New RC Manholes 12' deep	1.00	7,467	2,243	12,000	0	21,710	21710
B MIL 1	<02049 0610 >	Reinforced concrete headwalls incl forms, fill, etc.	95.00 CY	282.95 26,880	82.75 7,861	175.00 16,625	0.00 0	540.70 51,366	540.70
		TOTAL New RC Headwalls-2 ea	1.00	26,880	7,861	16,625	0	51,366	51366
M MIL 1	<05150 8250 >	5'x5' steel trash rack-assume stainless steel for better durability	2.00 EA	1316.16 2,632	304.48 609	4000.00 8,000	0.00 0	5620.65 11,241	5620.65
		TOTAL New 5'x5' Trash Racks	1.00	2,632	609	8,000	0	11,241	11241
B MIL 1	<02835 7770 >	Tide gate for 36" opening, automatic- prices per MII plus two year inflation and adjustment for steel increases.	1.00 EA	9558.36 9,558	3005.76 3,006	25000.00 25,000	0.00 0	37564.12 37,564	37564
		TOTAL New 36" gates	1.00	9,558	3,006	25,000	0	37,564	37564
B MIL 1	<02835 7775 >	Tide gate for 48" opening, automatic- Prices per MII plus two years markup for inflation and steel cost increases.	1.00 EA	9558.36 9,558	3005.76 3,006	30000.00 30,000	0.00 0	42564.12 42,564	42564
		TOTAL New 48" Tide Gates	1.00	9,558	3,006	30,000	0	42,564	42564
M MIL 1	<02161 0700 >	Sheet piling, stl, 32' exc,38 PSF,extrct&salvage, no wales wales- see plans for only partial sytem approx from ocean	425.00 TON	408.20 173,485	142.09 60,389	1190.00 505,750	0.00 0	1740.29 739,623	1740.29

IK.IO. Temporary Earth Support System		QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
	to 325' inland. See civil quantities of sf of sheetpile. GAQ.net quoted $1110/ton, Skymill, $1500/1lb, Strouts for $1200/lb								
MIL 1 <02161 2550 >	Sstl, connections & struts for sheet piles 2/3 salvage, wales			2368.79	761.21	186.83	0.00	3316.83	
		20.00	TON	47,376	15,224	3,737	0	66,337	3316.83
	TOTAL Temporary Earth Support System	1.00		220,860	75,613	509,487	0	805,960	805960
	TOTAL Water and Earth Control	1.00		543,974	121,846	813,164	0	1,478,984	1478984
M RSM 1 <01533 0010 >	Barricades, cones and barrels for lane assignment			31.74	0.00	8.00	0.00	39.74	
		120.00	LF	3,809	0	960	0	4,769	39.74
	TOTAL Barricades	1.00		3,809	0	960	0	4,769	4768.69
CIV 1 <02840 2000 >	Guide/guard rail, 2' wide, 3'-6" H, sgl, precast conc, median barrier			8.00	0.94	29.67	0.00	38.61	
		320.00	LF	2,560	300	9,494	0	12,355	38.61
	TOTAL Additional Barriers	1.00		2,560	300	9,494	0	12,355	12355
AF 1 <01580 0010 >	Sign, hi-intensity reflectorized, no posts, buy			0.00	0.00	13.98	0.00	13.98	
		100.00	SF	0	0	1,398	0	1,398	13.98
	TOTAL Signage	1.00		0	0	1,398	0	1,398	1398.00
MIL 1 <01036 0770 >	Field personnel, security officer			5172.41	0.00	0.00	0.00	5172.41	
		6.00	MO	31,034	0	0	0	31,034	5172.41
	TOTAL Police Detail	1.00		31,034	0	0	0	31,034	31034
B MIL 1 <02266 1110 >	Erosion control, fence only, silt fence, 3' high, w haybales polypropylene			2.32	0.00	2.50	0.00	4.82	
		820.00	LF	1,901	0	2,050	0	3,951	4.82
	TOTAL Erosion Control	1.00		1,901	0	2,050	0	3,951	3950.84
M MIL 1 <02505 0813 >	Bituminous conc pavement, 2.5" base, 1.5" wearing. Gernett Co, David Gier.			5.75	1.61	47.00	0.00	54.36	
		1400.00	SF	8,048	2,258	65,800	0	76,106	54.36

IP.HB. New Bituminous Conc. Pavement			QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
		TOTAL New Bituminous Conc. Pavement	1.00		8,048	2,258	65,800	0	76,106	76106
		TOTAL Sitework and Traffic Control	1.00		47,352	2,558	79,702	0	129,612	129612
B CIV 1	<05912 0140 >	Steel and wood tidal stoplog for 36" x 36" culvert slide gate-	1.00	EA	2273.79 2,274	482.91 483	1600.00 1,600	0.00 0	4356.70 4,357	4356.70
B CIV 1	<05912 0140 >	Reinforced concrete and wood board stoplog for 48"culvert- assume added costs to pour slots in new headwall and removable 4"x8" boards. Will have board storage compartment.	1.00	EA	1990.23 1,990	422.69 423	1600.00 1,600	0.00 0	4012.92 4,013	4012.92
		TOTAL Culvert Stoplogs in Pond	1.00	EA	4,264	906	3,200	0	8,370	8369.62
L MIL 1	<02232 0145 >	Excavate & load, hydr excavator, 2 CY, wet matl	741.00	CY	15.05 11,153	11.16 8,269	0.00 0	0.00 0	26.21 19,422	26.21
		TOTAL Excavate Sediment	1.00	EA	11,153	8,269	0	0	19,422	19422
L AF 1	<02215 2500 >	Haul, dump and spread excavated material on shorline.	741.00	CY	3.23 2,391	1.63 1,205	0.00 0	0.00 0	4.85 3,596	4.85
		TOTAL Place Sediment on Bank	1.00	EA	2,391	1,205	0	0	3,596	3595.95
L MIL 1	<02232 0140 >	Excavate & load, hydr excavator, 2 CY, medium matl	260.00	CY	3.05 792	2.26 587	0.00 0	0.00 0	5.30 1,379	5.30
L MIL 1	<02234 0340 >	Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	260.00	CY	5.27 1,371	6.08 1,580	0.00 0	0.00 0	11.35 2,951	11.35
		TOTAL Remove Temporary Road	1.00	EA	2,163	2,167	0	0	4,330	4330.44
L MIL 1	<02234 0545 >	Hauling, hwy haulers, 12 CY, 6 mi round trip @ 40 MPH, assume two truck loads, no disposal fee included, assume composting.	24.00	CY	7.42 178	8.54 205	0.00 0	0.00 0	15.96 383	15.96
B MIL 1	< >	Outside Laborers, (Semi-Skilled) power brush cut fragmites, bag and load in truck. Treat each individual stem with herbicide.	36.00	HR	42.65 1,535	0.00 0	4.00 144	0.00 0	46.65 1,679	46.65

IU.25. Remove Fragmites

	Description	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
	TOTAL Remove Fragmites	1.00 EA	1,713	205	144	0	2,062	2062.38
B MIL 1 <02932 0340 >	Seed shoreline area with switch grass,. Install seed with push spreader and lightly rack into soil. Soil used will be the excavated sediment that is placed and spread on shroe line.	9.00 CSY	15.43 139	0.00 0	24.00 216	0.00 0	39.43 355	39.43
MIL 1 < >	Laborers, (Semi-Skilled) rake seed into soil and install erosion control mulch hay to prevent erosion.	16.00 HR	52.16 835	0.00 0	0.00 0	0.00 0	52.16 835	52.16
L MIL 1 <02951 0760 >	Mulch, pine straw, 1" deep, hand spread	8000.00 SF	0.21 1,712	0.00 0	0.08 640	0.00 0	0.29 2,352	0.29
	TOTAL Seeding	1.00 EA	2,685	0	856	0	3,541	3541.38
AF 1 <01580 0010 >	Sign, hi-intensity reflectorized, no posts, buy	72.00 SF	0.00 0	0.00 0	13.98 1,007	0.00 0	13.98 1,007	13.98
B RSM 1 <01533 0010 >	Wood. movable saw horse barriers	400.00 LF	3.32 1,329	0.00 0	3.00 1,200	0.00 0	6.32 2,529	6.32
MIL 1 < >	Laborer, (Semi-Skilled) mobilization labor and equipment moves.	60.00 HR	52.16 3,129	0.00 0	0.00 0	0.00 0	52.16 3,129	52.16
MIL 1 <01036 0640 >	Field personnel, surveyor	0.20 MO	10582 2,116	0.00 0	0.00 0	0.00 0	10582.07 2,116	10582
MIL 1 <01036 0640 >	Field personnel, surveyor	0.20 MO	10582 2,116	0.00 0	0.00 0	0.00 0	10582.07 2,116	10582
MIL 1 < >	Laborer, (Semi-Skilled) demobilization labor and equipment moves.	60.00 HR	52.16 3,129	0.00 0	0.00 0	0.00 0	52.16 3,129	52.16
	TOTAL Mob and Demob	1.00 EA	11,820	0	2,207	0	14,027	14027
B MIL 1 <02215 2360 >	Backfill, spread dumped gravel/fill, dozer, 6" layers, light compaction.	260.00 CY	2.42 629	2.12 552	15.00 3,900	0.80 208	20.34 5,289	20.34

IU.45. Construct Temporary Road	QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
CIV 1 <02250 2130 > Geotextile fabric, 60 mil thick,			0.83	0.12	0.60	0.00	1.55	
non-woven polypropylene	612.00	SY	506	76	367	0	949	1.55
L AF 1 <02215 2500 > Haul and dump gravel to build			3.23	1.63	0.00	0.00	4.85	
temp road.	260.00	CY	839	423	0	0	1,262	4.85
TOTAL Construct Temporary Road	1.00	EA	1,974	1,050	4,267	208	7,500	7499.85
TOTAL Remove Fragmites	1.00	EA	0	0	0	0	0	0.00
TOTAL Remove Fragmites	1.00	EA	0	0	0	0	0	0.00
TOTAL Remove Fragmites	1.00	EA	0	0	0	0	0	0.00
TOTAL Excavate Pond/Create Fish Hole	1.00		38,165	13,802	10,674	208	62,849	62849
TOTAL Run Pond Alt 2 48" Culvert	1.00	EA	769,653	194,034	914,687	7,798	1,886,171	1886171

No errors detected...

* * * END OF ERROR REPORT * * *

Run Pond Alt 3 Twin Box Culverts
Remove 36" and 48" drainage
piping and install new twin 5'
x10' concrete box culverts w.
inlet and outlet structures

Designed By: CENAE
Estimated By: CENAE-E/P-MR

Prepared By: CENAE-E/P-Cost Engineering

Preparation Date: 11/14/07
Effective Date of Pricing: 11/06/07
Est Construction Time: 360 Days

Sales Tax: 0.0%

Remove some existing tide water drainage pipe and install new 36"RCP and twin 5'x10' concrete box culverts to improve tidal drainage. New outlets shall have a headwall, trash racks and Steinke tide gates. The temporary earth support system will consist of steel sheet piles. The site is easily accessible from South Shore Drive. Also, excavate 741 CY of sediment from the pond to create a fish habitat, and install adjustable stoplogs at 36" culvert and twin 5'x 10' box culverts. The following are the markups used: home office OH 6%, field office OH 10%, profit 10% and 1.5% bond. Contingency factor used is 15% because this is feasibility level estimate and there are no final construction specifications or detailed plans at this time.

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT RPAII3: Run Pond Alt 3 Twin Box Culverts - Remove 36" and 48" drainage
Project Cost
** PROJECT OWNER SUMMARY - Contract **

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
IK	Mob and Demob	1.00		13,674	2,051	0	15,725	15725
IP	Demolition	1.00		76,352	11,453	0	87,805	87805
IU	Earthwork	1.00		804,199	120,630	0	924,829	924829
IZ	Water Control	1.00		5,255,148	788,272	0	6,043,421	6043421
J4	Sitework and Traffic Control	1.00		309,174	46,376	0	355,550	355550
KI	Excavate Pond/Create Fish Hole	1.00		82,439	12,366	0	94,805	94805
TOTAL	Run Pond Alt 3 Twin Box Culverts	1.00	EA	6,540,987	981,148	0	7,522,135	7522135

** PROJECT OWNER SUMMARY - Feature **

		QUANTY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
IK	Mob and Demob						
IK.18	Mobilization and Setup at Site	1.00	9,378	1,407	0	10,785	10785
IK.23	Demobilize and Return Equipment	1.00	4,296	644	0	4,940	4939.96
TOTAL	Mob and Demob	1.00	13,674	2,051	0	15,725	15725
IP	Demolition						
IP.44	Pipe Removal and Disposal	1.00	23,190	3,478	0	26,668	26668
IP.49	Manhole Removal and Disposal	1.00	1,206	181	0	1,386	1386.37
IP.54	R/D conc. pavement	1.00	43,450	6,517	0	49,967	49967
IP.59	Utilitu Removal /Relocation	1.00	8,507	1,276	0	9,784	9783.52
TOTAL	Demolition	1.00	76,352	11,453	0	87,805	87805
IU	Earthwork						
IU.19	Earth Excavation	1.00	505,983	75,897	0	581,880	581880
IU.29	Backfill and culvert bedding	1.00	225,702	33,855	0	259,557	259557
IU.34	Compaction of fill materials	1.00	50,426	7,564	0	57,989	57989
IU.94	Channel Excavation	1.00	4,608	691	0	5,299	5298.90
IU.9E	Excavation with trench box	1.00	15,232	2,285	0	17,516	17516
IU.9J	Stone Bedding	1.00	2,250	337	0	2,587	2587.14
TOTAL	Earthwork	1.00	804,199	120,630	0	924,829	924829
IZ	Water Control						
IZ. N	Cofferdam at Wall & Sump Loc	1.00	56,401	8,460	0	64,861	64861
IZ.89	Well Points	1.00	743,035	111,455	0	854,490	854490
IZ.H6	RC drainage manholes	1.00	12,709	1,906	0	14,615	14615
IZ.HG	RC Headwalls-2 ea	1.00	62,592	9,389	0	71,981	71981
IZ.HL	5'x10' Trash Racks	1.00	14,569	2,185	0	16,754	16754
IZ.HV	Steinke Gates 5'x10'	1.00	233,292	34,994	0	268,286	268286
IZ.I0	Temporary Earth Support System	1.00	2,306,067	345,910	0	2,651,977	2651977
IZ.IA	Twin 5"x10' concrete box culvert	1.00	1,768,251	265,238	0	2,033,488	2033488
IZ.IF	36" diameter RCP	1.00	58,233	8,735	0	66,968	66968
TOTAL	Water Control	1.00	5,255,148	788,272	0	6,043,421	6043421
J4	Sitework and Traffic Control						
J4.64	Barricades	1.00	6,208	931	0	7,139	7139.28
J4.69	Additional Barriers	1.00	16,056	2,408	0	18,465	18465
J4.74	Signage	1.00	1,820	273	0	2,093	2092.97

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
J4.79	Police Detail	1.00		40,402	6,060	0	46,462	46462
J4.84	Erosion Control	1.00		5,143	772	0	5,915	5914.86
J4.HB	Bituminous Conc. Pavement	1.00		239,545	35,932	0	275,476	275476
TOTAL	Sitework and Traffic Control	1.00		309,174	46,376	0	355,550	355550
KI	Excavate Pond/Create Fish Hole							
KI. 5	Construct Temporary Road	1.00	EA	14,684	2,203	0	16,887	16887
KI.10	Excavate Sediment	1.00	EA	14,198	2,130	0	16,327	16327
KI.15	Place Sediment on Bank	1.00	EA	4,591	689	0	5,279	5279.43
KI.20	Remove Temporary Road	1.00	EA	3,488	523	0	4,011	4010.77
KI.25	Remove Fragmites	1.00	EA	2,646	397	0	3,043	3043.34
KI.30	Seeding	1.00	EA	4,610	692	0	5,302	5301.85
KI.35	Mob and Demob	1.00	EA	18,261	2,739	0	21,000	21000
KI.40	Culvert Stoplogs in Pond	1.00	EA	19,961	2,994	0	22,955	22955
TOTAL	Excavate Pond/Create Fish Hole	1.00		82,439	12,366	0	94,805	94805
TOTAL	Run Pond Alt 3 Twin Box Culverts	1.00	EA	6,540,987	981,148	0	7,522,135	7522135

SUMMARY REPORTS — SUMMARY PAGE

DETAILED ESTIMATE — DETAIL PAGE

No Backup Reports...

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No errors detected...

* * * END OF ERROR REPORT * * *

IK.18. Mobilization and Setup at Site		QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
AF 1 <01594 1400 >	Toilet, portable chemical, rent		0.00	0.00	80.17	0.00	80.17	
	per mon, 2 ea x 6 mon. say 12	24.00 EA	0	0	1,924	0	1,924	80.17
AF 1 <01594 0350 >	Office trailer, rent per month,		0.00	0.00	165.00	0.00	165.00	
	furnished, no hookups, 32' x 8'	12.00 MO	0	0	1,980	0	1,980	165.00
USR 1 <01594 0300 >	mobilize, prepare and deliver		499.94	0.00	50.00	0.00	549.94	
	materials and equipment	6.00 EA	3,000	0	300	0	3,300	549.94
	TOTAL Mobilization and Setup at Site	1.00	3,000	0	4,204	0	7,204	7203.74
B RSM 1 <01594 0300 >	Demobilize Move Equipment and		499.94	0.00	50.00	0.00	549.94	
	Materials	6.00 EA	3,000	0	300	0	3,300	549.94
	TOTAL Demobilize and Return Equipment	1.00	3,000	0	300	0	3,300	3299.66
	TOTAL Mob and Demob	1.00	5,999	0	4,504	0	10,503	10503
B MIL 1 <02752 4500 >	removal and disposal of 48"RCP		43.00	4.32	9.00	0.00	56.32	
		250.00 LF	10,750	1,080	2,250	0	14,079	56.32
B MIL 1 <02752 4500 >	removal and disposal of 36"RCP		17.93	1.80	3.61	0.00	23.34	
		160.00 LF	2,868	288	578	0	3,734	23.34
	TOTAL Pipe Removal and Disposal	1.00	13,618	1,368	2,828	0	17,813	17813
B HTW 1 <02086 5741 >	Manhole removal and disposal		796.02	130.01	0.00	0.00	926.03	
		1.00 EA	796	130	0	0	926	926.03
	TOTAL Manhole Removal and Disposal	1.00	796	130	0	0	926	926.03
L MIL 1 <02049 0605 >	Remove and dispose of bit. conc.		7.54	2.06	0.00	0.00	9.59	
	pavement	3000.00 SY	22,609	6,168	0	0	28,777	9.59
L AF 1 <02234 4000 >	Hauling bit.conc, w/loading, 12		7.67	7.66	0.00	0.00	15.33	
	CY truck, 5 mile haul, soil	300.00 CY	2,301	2,297	0	0	4,598	15.33
	TOTAL R/D conc. pavement	1.00	24,910	8,465	0	0	33,376	33376
B MIL 1 <02658 3000 >	Remove storm drain line		32.63	9.10	0.00	0.00	41.73	
		50.00 LF	1,631	455	0	0	2,086	41.73
L MIL 1 <02662 3020 >	Piping, water dist, 2" dia, 20'		30.65	0.00	4.31	0.00	34.96	
	joints, copper, tubing, type K	50.00 LF	1,533	0	216	0	1,748	34.96

IP.59. Utilitu Removal /Relocation		QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
USR 1	<02658 3000 > diconnect water meter		912.97	254.62	0.00	0.00	1167.59	
		1.00 LS	913	255	0	0	1,168	1167.59
USR 1	<02662 3020 > Remove O/H electrical line		30.65	0.00	0.00	0.00	30.65	
		50.00 LF	1,533	0	0	0	1,533	30.65
	TOTAL Utilitu Removal /Relocation	1.00	5,610	710	216	0	6,535	6534.92
	TOTAL Demolition	1.00	44,934	10,673	3,043	0	58,650	58650
B MIL 1	<02228 0322 > excavation for two two 5'x10'		8.39	3.90	3.00	0.00	15.29	
	conc culverts	9600.00 CY	80,578	37,442	28,800	0	146,820	15.29
B MIL 1	<02228 0322 > excavation of existing 36"		8.39	3.90	3.00	0.00	15.29	
	culvert	13000 CY	109,116	50,703	39,000	0	198,819	15.29
B MIL 1	<02228 0322 > channel excavation		41.97	19.50	0.00	0.00	61.47	
		700.00 CY	29,378	13,651	0	0	43,029	61.47
	TOTAL Earth Excavation	1.00	219,071	101,797	67,800	0	388,668	388668
B MIL 1	<02215 2460 > foundation bedding material for		5.53	2.63	10.00	0.00	18.16	
	box culverts 6" deep	1100.00 CY	6,085	2,889	11,000	0	19,974	18.16
B MIL 1	<02215 2460 > Select fill for removed 36" and		5.53	2.63	10.00	0.00	18.16	
	new 48"culverts	2800.00 CY	15,489	7,355	28,000	0	50,844	18.16
MIL 1	<02215 2460 > Backfill box culvert trench		1.89	0.90	15.20	0.00	17.99	
	front-end loader, 1.5 CY	5700.00 CY	10,790	5,123	86,640	0	102,553	17.99
	TOTAL Backfill and culvert bedding	1.00	32,364	15,367	125,640	0	173,371	173371
MIL 1	<02220 6400 > Compaction, 1 ton roller, around		3.60	0.44	0.00	0.00	4.03	
	structures & trenches	9600.00 CY	34,528	4,206	0	0	38,734	4.03
	TOTAL Compaction of fill materials	1.00	34,528	4,206	0	0	38,734	38734
L MIL 1	<02228 0320 > channel excavation, includes		17.41	8.09	0.00	4.00	29.50	
	dewatering and hauling	120.00 CY	2,089	971	0	480	3,539	29.50
	TOTAL Channel Excavation	1.00	2,089	971	0	480	3,539	3539.41
L CIV 1	<02228 3120 > 10' x 20' trench box rental 3		0.00	3900.00	0.00	0.00	3900.00	
	months	3.00 MO	0	11,700	0	0	11,700	3900.00

IU.9E. Excavation with trench box	QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
TOTAL Excavation with trench box	1.00		0	11,700	0	0	11,700	11700
MIL 1 <02244 0100 > Base course, crushed 3/4" stone,			0.47	0.36	4.03	0.00	4.87	
compacted, 6"D, large areas	355.00	SY	168	129	1,431	0	1,728	4.87
TOTAL Stone Bedding	1.00		168	129	1,431	0	1,728	1728.09
TOTAL Earthwork	1.00		288,220	134,170	194,871	480	617,741	617741
B MIL 1 <02161 0400 > Sheet piling, stl, 32' exc,38			400.99	131.60	370.00	0.00	902.59	
PSF,drive,extrct&salvage, no wales	48.00	TON	19,248	6,317	17,760	0	43,324	902.59
TOTAL Cofferdam at Wall & Sump Loc	1.00		19,248	6,317	17,760	0	43,324	43324
B RSM 1 <02144 1000 > Wellpoint system for 4-7 months			207.09	0.00	110.00	0.00	317.09	
	1800.00	LF	372,758	0	198,000	0	570,758	317.09
TOTAL Well Points	1.00		372,758	0	198,000	0	570,758	570758
B MIL 1 <16711 1900 > Drainage, sewer standard,			1861.81	519.24	2000.00	0.00	4381.05	
manhole	1.00	EA	1,862	519	2,000	0	4,381	4381.05
B MIL 1 <16711 1900 > Drainage, sewer 12' deep,			1861.81	519.24	3000.00	0.00	5381.05	
manhole	1.00	EA	1,862	519	3,000	0	5,381	5381.05
TOTAL RC drainage manholes	1.00		3,724	1,038	5,000	0	9,762	9762.10
B MIL 1 <02049 0610 > Reinforced concrete headwalls			282.22	77.00	175.00	0.00	534.22	
incl forms, fill, etc.	90.00	CY	25,400	6,930	15,750	0	48,080	534.22
TOTAL RC Headwalls-2 ea	1.00		25,400	6,930	15,750	0	48,080	48080
B MIL 1 <05150 8250 > 5'x10' stainless steel trash			1313.50	281.91	4000.00	0.00	5595.41	
racks	2.00	EA	2,627	564	8,000	0	11,191	5595.41
TOTAL 5'x10' Trash Racks	1.00		2,627	564	8,000	0	11,191	11191
B MIL 1 <02835 7775 > Steinke Gates for 5'x10' conc			26810	7791.09	55000.00	0.00	89601.11	
box culverts - prices	2.00	EA	53,620	15,582	110,000	0	179,202	89601
TOTAL Steinke Gates 5'x10'	1.00		53,620	15,582	110,000	0	179,202	179202

IZ.I0. Temporary Earth Support System		QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
B MIL 1 <02161 0700 >	Sheet piling, stl, 32' exc,38			404.57	132.77	1190.00	0.00	1727.34	
	PSF, extrct&salvage, no wales wales-adjusted from price book, added appprox,.10% for 2004 steel increases - Contractor may alread own sheetpile or consider sheet pile rental to lower costs.	950.00	TON	384,342	126,134	1,130,500	0	1,640,976	1727.34
MIL 1 <02161 2550 >	Sstl, connections & struts for			2368.79	704.79	186.83	0.00	3260.41	
	sheet piles 2/3 salvage, wales	40.00	TON	94,752	28,191	7,473	0	130,416	3260.41
TOTAL	Temporary Earth Support System	1.00		479,093	154,325	1,137,973	0	1,771,392	1771392
B MIL 1 <03491 0010 >	Precase 5'x10' concrete box			87.64	17.89	600.00	0.00	705.52	
	culverts panel	1800.00	EA	157,749	32,196	1,080,000	0	1,269,945	705.52
B MIL 1 <02228 0322 >	concrete pad for culverts			9.79	4.55	75.00	0.00	89.34	
		950.00	CY	9,303	4,323	71,250	0	84,876	89.34
MIL 1 <03356 0410 >	Grout, non-metallic, non-shrink,			1.21	0.09	0.10	0.00	1.40	
	joint, 1/2" x 6" wide- for joints in 48" concrete drainage pipe	2460.00	LF	2,987	218	246	0	3,451	1.40
TOTAL	Twin 5"x10' concrete box culvert	1.00		170,038	36,737	1,151,496	0	1,358,271	1358271
M MIL 1 <02762 2060 >	Piping, drainage & sewage, 36"			42.12	11.75	45.90	0.00	99.76	
	dia, RCP, class 3, no gasketsGAQ	440.00	LF	18,532	5,168	20,196	0	43,896	99.76
B MIL 1 <03356 0410 >	Grout, non-metallic, non-shrink,			2.41	0.18	0.20	0.00	2.78	
	joint, 1/2" x 6" wide	300.00	LF	722	53	60	0	835	2.78
TOTAL	36" diameter RCP	1.00		19,254	5,221	20,256	0	44,732	44732
TOTAL	Water Control	1.00		1145762	226,714	2,664,235	0	4,036,711	4036711
M RSM 1 <01533 0010 >	Barricades, cones and barrels			31.74	0.00	8.00	0.00	39.74	
	for lane assignment	120.00	LF	3,809	0	960	0	4,769	39.74
TOTAL	Barricades	1.00		3,809	0	960	0	4,769	4768.69
CIV 1 <02840 2000 >	Jersey barrier, 2' wide, 3'-6"			7.98	0.89	29.67	0.00	38.54	
	H, sgl, precast conc, barrier	320.00	LF	2,554	286	9,494	0	12,334	38.54

J4.69. Additional Barriers	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
TOTAL Additional Barriers	1.00	2,554	286	9,494	0	12,334	12334
AF 1 <01580 0010 > Sign, hi-intensity		0.00	0.00	13.98	0.00	13.98	
reflectorized, no posts, buy	100.00 SF	0	0	1,398	0	1,398	13.98
TOTAL Signage	1.00	0	0	1,398	0	1,398	1398.00
MIL 1 <01036 0770 > Field personnel, security		5172.41	0.00	0.00	0.00	5172.41	
officer	6.00 MO	31,034	0	0	0	31,034	5172.41
TOTAL Police Detail	1.00	31,034	0	0	0	31,034	31034
B MIL 1 <02266 1110 > Erosion control, fence only,		2.32	0.00	2.50	0.00	4.82	
silt fence, 3' high, w haybales polypropylene	820.00 LF	1,901	0	2,050	0	3,951	4.82
TOTAL Erosion Control	1.00	1,901	0	2,050	0	3,951	3950.84
B MIL 1 <02505 0813 > Bituminous conc pavement, 2.5"		11.32	3.01	47.00	0.00	61.33	
base, 1.5" wearing	3000.00 SY	33,974	9,031	141,000	0	184,005	61.33
TOTAL Bituminous Conc. Pavement	1.00	33,974	9,031	141,000	0	184,005	184005
TOTAL Sitework and Traffic Control	1.00	73,271	9,317	154,902	0	237,490	237490
L MIL 1 <02215 2360 > Backfill, spread dumped		2.42	1.95	0.00	0.80	5.17	
gravel/fill, dozer, 6" layers, light compaction.	260.00 CY	629	507	0	208	1,344	5.17
CIV 1 <02250 2130 > Geotextile fabric, 60 mil thick,		0.83	0.10	0.60	0.00	1.53	
non-woven polypropylene	612.00 SY	506	63	367	0	937	1.53
L AF 1 <02215 2500 > Haul and dump gravel to build		3.23	1.53	0.00	0.00	4.76	
temp road.	260.00 CY	839	398	0	0	1,237	4.76
B CIV 1 <05912 0140 > Steel and wood tidal stoplog for		1982.39	398.36	1600.00	0.00	3980.75	
36" x 36" culvert slide gate- assume steel brackets and 4" x 8" PT wood slide in boards.	1.00 EA	1,982	398	1,600	0	3,981	3980.75
B CIV 1 <05912 0140 > Reinforced concrete and wood		1982.39	398.36	1400.00	0.00	3780.75	
board stoplog for 48"culvert- assume added costs to pour slots in new headwall and removable 4"x8" boards.	1.00 EA	1,982	398	1,400	0	3,781	3780.75

KI. 5. Construct Temporary Road		QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
	TOTAL Construct Temporary Road	1.00 EA	5,939	1,765	3,367	208	11,280	11280
L MIL 1 <02232 0145 >	Excavate & load, hydr excavator,		8.70	6.01	0.00	0.00	14.72	
	2 CY, wet matl	741.00 CY	6,450	4,456	0	0	10,906	14.72
	TOTAL Excavate Sediment	1.00 EA	6,450	4,456	0	0	10,906	10906
L AF 1 <02215 2500 >	Haul, dump and spread excavated		3.23	1.53	0.00	0.00	4.76	
	material on shorline.	741.00 CY	2,391	1,135	0	0	3,526	4.76
	TOTAL Place Sediment on Bank	1.00 EA	2,391	1,135	0	0	3,526	3526.40
L MIL 1 <02232 0140 >	Excavate & load, hydr excavator,		3.05	2.10	0.00	0.00	5.15	
	2 CY, medium matl	260.00 CY	792	547	0	0	1,339	5.15
L MIL 1 <02234 0340 >	Hauling, hwy haulers, 12 CY, 1		2.60	2.56	0.00	0.00	5.15	
	mi round trip @ 20 MPH (4.2 cyc/hr)	260.00 CY	675	665	0	0	1,340	5.15
	TOTAL Remove Temporary Road	1.00 EA	1,467	1,212	0	0	2,679	2679.00
L MIL 1 <02234 0545 >	Hauling, hwy haulers, 12 CY, 6		7.42	7.31	0.00	0.00	14.73	
	mi round trip @ 40 MPH, assume two truck loads, no disposal fee included, assume composting.	24.00 CY	178	175	0	0	353	14.73
B MIL 1 < >	Outside Laborers, (Semi-Skilled)		42.65	0.00	4.00	0.00	46.65	
	power brush cut fragmites, bag and load in truck. Treat each individual stem with herbicide.	36.00 HR	1,535	0	144	0	1,679	46.65
	TOTAL Remove Fragmites	1.00 EA	1,713	175	144	0	2,033	2032.80
B MIL 1 <02932 0340 >	Seed shoreline area with switch		15.43	0.00	24.00	0.00	39.43	
	grass,. Install seed with push spreader and lightly rack into soil. Soil used will be the excavated sediment that is placed and spread on shroe line.	9.00 CSY	139	0	216	0	355	39.43
MIL 1 < >	Laborers, (Semi-Skilled) rake		52.16	0.00	0.00	0.00	52.16	
	seed into soil and install erosion control mulch hay to	16.00 HR	835	0	0	0	835	52.16

KI.30. Seeding	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
prevent erosion.							
L MIL 1 <02951 0760 > Mulch, pine straw, 1" deep, hand spread	8000.00 SF	0.21 1,712	0.00 0	0.08 640	0.00 0	0.29 2,352	0.29
TOTAL Seeding	1.00 EA	2,685	0	856	0	3,541	3541.38
AF 1 <01580 0010 > Sign, hi-intensity reflectorized, no posts, buy	72.00 SF	0.00 0	0.00 0	13.98 1,007	0.00 0	13.98 1,007	13.98
B RSM 1 <01533 0010 > Wood. movable saw horse barriers	400.00 LF	3.32 1,329	0.00 0	3.00 1,200	0.00 0	6.32 2,529	6.32
MIL 1 < > Laborer, (Semi-Skilled) mobilization labor and equipment moves.	60.00 HR	52.16 3,129	0.00 0	0.00 0	0.00 0	52.16 3,129	52.16
MIL 1 <01036 0640 > Field personnel, surveyor	0.20 MO	10582 2,116	0.00 0	0.00 0	0.00 0	10582.07 2,116	10582
MIL 1 <01036 0640 > Field personnel, surveyor	0.20 MO	10582 2,116	0.00 0	0.00 0	0.00 0	10582.07 2,116	10582
MIL 1 < > Laborer, (Semi-Skilled) demobilization labor and equipment moves.	60.00 HR	52.16 3,129	0.00 0	0.00 0	0.00 0	52.16 3,129	52.16
TOTAL Mob and Demob	1.00 EA	11,820	0	2,207	0	14,027	14027
B CIV 1 <05912 0140 > Steel and wood tidal stoplog for 36" culvert - assume steel brackets and 4" x 8" PT wood slide in boards. Will have board storage compartment.	1.00 EA	2407.19 2,407	483.72 484	1600.00 1,600	0.00 0	4490.91 4,491	4490.91
B CIV 1 <05912 0140 > Reinforced concrete and wood board stoplog for twin 5' x 10' box culverts. Assume concrete slots with 4"x 8" removable boards. Will have board storage compartment. Estimator assumes type of design.	1.00 EA	5947.17 5,947	1195.08 1,195	3700.00 3,700	0.00 0	10842.25 10,842	10842
TOTAL Culvert Stoplogs in Pond	1.00 EA	8,354	1,679	5,300	0	15,333	15333
TOTAL Excavate Pond/Create Fish Hole	1.00	40,820	10,424	11,874	208	63,325	63325

KI.40. Culvert StoploGs in Pond	QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
TOTAL Run Pond Alt 3 Twin Box Culverts	1.00	EA	1599007	391,297	3,033,429	688	5,024,421	5024421

Run Pond Alt 4 conc."U" channel
Remove 48" drainage cul., boat
ramp and install two new 5'x10'
box cul. under road and 900' of
U channel & new boat ramp

Designed By: CENAE
Estimated By: CENAE-E/P-MR

Prepared By: CENAE-E/P-Cost Engineering

Preparation Date: 11/27/07
Effective Date of Pricing: 11/27/07
Est Construction Time: 360 Days

Sales Tax: 0.0%

Currency in DOLLARS

To improve tidal drainage, remove a portion of the existing 48" tide water drainage pipe and install new, open, 20' wide,"U" channel, and twin 5'x10' concrete box culverts under a road. New drainage inlet and outlet shall have headwalls and trash racks. One automatic tide gate is required. The project also includes removal of an existing boat ramp and construction of a new boat ramp at a different location. The temporary earth support system will consist of steel sheet piles. Also, excavate 741 CY of sediment from the pond to create a fish habitat, and construct adjustable stoplogs for the 36" culvert and the 11'x 20'concrete U channel. The site is easily accessed by use of South Shore Drive. The following are the markups used: home office OH 6%, field office OH 10%, profit 10% and 1.5% bond. Contingency factor used is 15% because this is feasibility level estimate and there are no final construction specifications or detailed plans at this time.

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT RPAII4: Run Pond Alt 4 conc."U" channel - Remove 48" drainage cul., boat
Project Cost
** PROJECT OWNER SUMMARY - Contract **

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
JJ Mob and Demob	1.00		13,981	2,097	0	16,078	16078
JO Demolition	1.00		131,781	19,767	0	151,548	151548
JT Earthwork	1.00		795,617	119,343	0	914,960	914960
JY Water Control	1.00		3,464,561	519,684	0	3,984,246	3984246
K3 Sitework and Traffic Control	1.00		1,105,047	165,757	0	1,270,804	1270804
L1 Excavate Pond/Create Fish Hole	1.00		72,350	10,853	0	83,203	83203
TOTAL Run Pond Alt 4 conc."U" channel	1.00	EA	5,583,338	837,501	0	6,420,838	6420838

** PROJECT OWNER SUMMARY - Feature **

	QUANTY UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
JJ Mob and Demob						
JJ.18 Mobilization and Setup at Site	1.00	9,685	1,453	0	11,138	11138
JJ.23 Demobilize and Return Equipment	1.00	4,296	644	0	4,940	4939.96
TOTAL Mob and Demob	1.00	13,981	2,097	0	16,078	16078
JO Demolition						
JO.44 Pipe Removal and Disposal	1.00	21,480	3,222	0	24,702	24702
JO.54 R/D conc. pavement	1.00	49,315	7,397	0	56,712	56712
JO.59 Utilitu Removal /Relocation	1.00	8,294	1,244	0	9,538	9538.36
JO.IK Demolish boat ramp	1.00	52,692	7,904	0	60,595	60595
TOTAL Demolition	1.00	131,781	19,767	0	151,548	151548
JT Earthwork						
JT.19 Earth Excavation	1.00	626,071	93,911	0	719,981	719981
JT.29 Backfill and culvert bedding	1.00	103,886	15,583	0	119,469	119469
JT.34 Compaction of fill materials	1.00	49,162	7,374	0	56,536	56536
JT.94 Channel Excavation	1.00	4,316	647	0	4,964	4963.56
JT.9E Excavation with trench box	1.00	11,717	1,757	0	13,474	13474
JT.9J Stone Bedding	1.00	466	70	0	536	536.37
TOTAL Earthwork	1.00	795,617	119,343	0	914,960	914960
JY Water Control						
JY. N Cofferdam during construction	1.00	760,896	114,134	0	875,031	875031
JY.HG RC Headwalls-3 ea	1.00	38,768	5,815	0	44,584	44584
JY.HL Trash Racks	1.00	55,910	8,386	0	64,296	64296
JY.HV Steinke Gates 5'x10'	1.00	216,156	32,423	0	248,579	248579
JY.IO Temporary Earth Support System	1.00	1,361,464	204,220	0	1,565,684	1565684
JY.IA Twin 5"x10' concrete box culvert	1.00	208,511	31,277	0	239,787	239787
JY.IF 36" diameter RCP	1.00	11,371	1,706	0	13,077	13077
JY.IZ 11' x 20' concrete "U" channel	1.00	811,485	121,723	0	933,208	933208
TOTAL Water Control	1.00	3,464,561	519,684	0	3,984,246	3984246
K3 Sitework and Traffic Control						
K3.64 Barricades	1.00	6,208	931	0	7,139	7139.28
K3.69 Additional Barriers & Guardrail	1.00	33,450	5,017	0	38,467	38467
K3.74 Signage	1.00	1,820	273	0	2,093	2092.97
K3.79 Police Detail	1.00	40,402	6,060	0	46,462	46462

** PROJECT OWNER SUMMARY - Feature **

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
K3.84	Erosion Control	1.00		5,143	772	0	5,915	5914.86
K3.89	Well Points	1.00		720,972	108,146	0	829,117	829117
K3.HB	Bituminous Conc. Pavement	1.00		45,925	6,889	0	52,814	52814
K3.IP	Construct Boat Ramp	1.00		150,847	22,627	0	173,474	173474
K3.IU	7' wide bit con. walkway	1.00		38,499	5,775	0	44,274	44274
K3.J9	Safety Railing	1.00		42,942	6,441	0	49,383	49383
K3.JE	Concrete Curb	1.00		18,838	2,826	0	21,664	21664
TOTAL	Sitework and Traffic Control	1.00		1,105,047	165,757	0	1,270,804	1270804
L1	Excavate Pond/Create Fish Hole							
L1. 5	Construct Temporary Road	1.00	EA	4,289	643	0	4,932	4932.38
L1.10	Excavate Sediment	1.00	EA	12,859	1,929	0	14,788	14788
L1.15	Place Sediment on Bank	1.00	EA	4,250	637	0	4,887	4887.18
L1.20	Remove Temporary Road	1.00	EA	3,123	469	0	3,592	3591.92
L1.25	Remove Fragmites	1.00	EA	2,594	389	0	2,983	2982.72
L1.30	Seeding	1.00	EA	4,610	692	0	5,302	5301.85
L1.35	Mob and Demob	1.00	EA	18,261	2,739	0	21,000	21000
L1.40	Culvert Stoplogs in Pond	1.00	EA	22,365	3,355	0	25,719	25719
TOTAL	Excavate Pond/Create Fish Hole	1.00		72,350	10,853	0	83,203	83203
TOTAL	Run Pond Alt 4 conc."U" channel	1.00	EA	5,583,338	837,501	0	6,420,838	6420838

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

JJ.18. Mobilization and Setup at Site

	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
M AF 1 <01594 1400 > Toilet, portable chemical, rent per month	24.00 EA	0.00 0	0.00 0	90.00 2,160	0.00 0	90.00 2,160	90.00
AF 1 <01594 0350 > Office trailer, rent per month, furnished, no hookups, 32' x 8'	12.00 MO	0.00 0	0.00 0	165.00 1,980	0.00 0	165.00 1,980	165.00
USR 1 <01594 0300 > mobilize, prepare, deliver materials and equipment	6.00 EA	499.94 3,000	0.00 0	50.00 300	0.00 0	549.94 3,300	549.94
TOTAL Mobilization and Setup at Site	1.00	3,000	0	4,440	0	7,440	7439.66
B RSM 1 <01594 0300 > Demobilize, Move Equipment and Materials	6.00 EA	499.94 3,000	0.00 0	50.00 300	0.00 0	549.94 3,300	549.94
TOTAL Demobilize and Return Equipment	1.00	3,000	0	300	0	3,300	3299.66
TOTAL Mob and Demob	1.00	5,999	0	4,740	0	10,739	10739
B MIL 1 <02752 4500 > removal and disposal of 48"RCP	300.00 LF	43.00 12,899	3.32 997	0.00 0	8.68 2,604	55.00 16,500	55.00
TOTAL Pipe Removal and Disposal	1.00	12,899	997	0	2,604	16,500	16500
L MIL 1 <02049 0605 > Remove and dispose of bit. conc. pavement	3700.00 SY	7.54 27,885	1.58 5,852	0.00 0	0.00 0	9.12 33,737	9.12
L AF 1 <02234 4000 > Hauling bit.conc, w/loading, 12 CY truck, 5 mile haul, soil	300.00 CY	7.81 2,344	6.00 1,800	0.00 0	0.00 0	13.81 4,144	13.81
TOTAL R/D conc. pavement	1.00	30,229	7,652	0	0	37,881	37881
B MIL 1 <02658 3000 > Remove storm drain line	50.00 LF	32.63 1,631	7.00 350	0.00 0	0.00 0	39.63 1,981	39.63
L MIL 1 <02662 3020 > Piping, water dist, 2" dia, 20' joints, copper, tubing, type K	50.00 LF	30.65 1,533	0.00 0	4.31 216	0.00 0	34.96 1,748	34.96
USR 1 <02658 3000 > diconnect water meter	1.00 LS	912.97 913	195.86 196	0.00 0	0.00 0	1108.83 1,109	1108.83
USR 1 <02662 3020 > Remove O/H electrical line	50.00 LF	30.65 1,533	0.00 0	0.00 0	0.00 0	30.65 1,533	30.65
TOTAL Utilitu Removal /Relocation	1.00	5,610	546	216	0	6,371	6371.16

JO.IK. Demolish boat ramp	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
L MIL 1 <02056 1050 > demo existing reinforced concrete boat ramp	1400.00 CF	24.98 34,977	0.98 1,375	0.00 0	0.00 0	25.97 36,352	25.97
L MIL 1 <02056 1050 > demo and dispose of existing wood boat ramp walkways and pile	80.00 LF	38.44 3,075	1.51 121	0.00 0	0.00 0	39.95 3,196	39.95
L MIL 1 <02234 0545 > Hauling, hwy haulers, 12 CY, 6 mi round trip @ 40 MPH (2.1 cyc/hr)	80.00 CY	6.59 527	5.00 400	0.00 0	0.00 0	11.59 927	11.59
TOTAL Demolish boat ramp	1.00	38,579	1,896	0	0	40,475	40475
TOTAL Demolition	1.00	87,317	11,090	216	2,604	101,227	101227
B MIL 1 <02228 0322 > excavation for two 5'x10' conc culverts, incl dewatering & haul	700.00 CY	41.97 29,378	15.00 10,501	0.00 0	0.00 0	56.97 39,878	56.97
B MIL 1 <02228 0322 > excavation of existing 48" culvert, incl dewater & haul	1300.00 CY	41.97 54,558	15.00 19,502	0.00 0	0.00 0	56.97 74,060	56.97
B MIL 1 <02228 0322 > Excavation for "U" channel, incl dewater & haul	8556.00 CY	31.33 268,076	11.20 95,822	0.00 0	0.00 0	42.53 363,898	42.53
USR 1 <02228 0322 > excavation for new 36" culvert, incl dewater & haul	270.00 CY	8.39 2,266	3.00 810	0.00 0	0.00 0	11.39 3,076	11.39
TOTAL Earth Excavation	1.00	354,278	126,635	0	0	480,913	480913
B MIL 1 <02215 2460 > foundation bedding material for "U" channel 6" deep	450.00 CY	5.53 2,489	2.02 909	10.00 4,500	0.00 0	17.55 7,899	17.55
B MIL 1 <02215 2460 > Select fill	2850.00 CY	5.53 15,766	2.02 5,758	10.00 28,500	0.00 0	17.55 50,024	17.55
M MIL 1 <02215 2460 > Backfill box culvert and "U" front-end loader, 1.5 CY	1500.00 CY	1.89 2,840	0.69 1,037	12.00 18,000	0.00 0	14.58 21,877	14.58
TOTAL Backfill and culvert bedding	1.00	21,094	7,705	51,000	0	79,799	79799
MIL 1 <02220 6400 > Compaction, 1 ton roller, around structures & trenches	9600.00 CY	3.60 34,528	0.34 3,235	0.00 0	0.00 0	3.93 37,764	3.93
TOTAL Compaction of fill materials	1.00	34,528	3,235	0	0	37,764	37764
L MIL 1 <02228 0320 > channel excavation, includes dewatering and hauling	120.00 CY	17.41 2,089	6.22 747	0.00 0	4.00 480	27.63 3,315	27.63

JT.94. Channel Excavation		QUANTY	UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
	TOTAL Channel Excavation	1.00		2,089	747	0	480	3,315	3315.42
L CIV 1	<02228 3120 > 10' x 20' trench box rental 3 months			0.00	3000.00	0.00	0.00	3000.00	
		3.00	MO	0	9,000	0	0	9,000	3000.00
	TOTAL Excavation with trench box	1.00		0	9,000	0	0	9,000	9000.00
B MIL 1	<02244 0100 > Base course for 36" culve, crushed 3/4" stone, compacted, 6			1.83	1.08	15.00	0.00	17.91	
		20.00	CY	37	22	300	0	358	17.91
	TOTAL Stone Bedding	1.00		37	22	300	0	358	358.27
	TOTAL Earthwork	1.00		412,026	147,343	51,300	480	611,149	611149
B MIL 1	<02161 0400 > Sheet piling, stl, 32' exc,38PSF,drive,extrct&salvage, wales			440.53	111.21	1190.00	0.00	1741.74	
		300.00	TON	132,159	33,363	357,000	0	522,523	1741.74
MIL 1	<02161 2550 > Sstl, connections & struts for sheet piles 2/3 salvage, wales			2368.79	542.14	186.83	0.00	3097.76	
		20.00	TON	47,376	10,843	3,737	0	61,955	3097.76
	TOTAL Cofferdam during construction	1.00		179,535	44,206	360,737	0	584,478	584478
B MIL 1	<02049 0610 > Reinforced concrete headwalls incl forms, fill, etc.			282.22	59.23	200.00	0.00	541.45	
		55.00	CY	15,522	3,258	11,000	0	29,780	541.45
	TOTAL RC Headwalls-3 ea	1.00		15,522	3,258	11,000	0	29,780	29780
B MIL 1	<05150 8250 > 5'x10' stainless steel trash racks			1313.50	216.86	5000.00	0.00	6530.35	
		2.00	EA	2,627	434	10,000	0	13,061	6530.35
B MIL 1	<05150 8250 > 10' X 20' stainless steel trash rack			4242.56	700.44	10000.00	0.00	14943.00	
		2.00	EA	8,485	1,401	20,000	0	29,886	14943
	TOTAL Trash Racks	1.00		11,112	1,835	30,000	0	42,947	42947
B MIL 1	<02835 7775 > Steinke Gates for 5'x10' conc box culverts			22900	5119.15	55000.00	0.00	83019.38	
		2.00	EA	45,800	10,238	110,000	0	166,039	83019
	TOTAL Steinke Gates 5'x10'	1.00		45,800	10,238	110,000	0	166,039	166039

JY.IO. Temporary Earth Support System			QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
B MIL 1	<02161 0700 >	Sheet piling, stl, 32' exc,38		440.53	111.21	341.00	0.00	892.74	
		PSF,extrct&salvage, no wales wales	1050.00 TON	462,558	116,771	358,050	0	937,379	892.74
MIL 1	<02161 2550 >	Sstl, connections & struts for		2368.79	542.14	186.83	0.00	3097.76	
		sheet piles 2/3 salvage, wales	35.00 TON	82,908	18,975	6,539	0	108,422	3097.76
	TOTAL	Temporary Earth Support System	1.00	545,466	135,746	364,589	0	1,045,801	1045801
B MIL 1	<03491 0010 >	Precast 5'x10' concrete box		151.10	23.72	600.00	0.00	774.82	
		culverts	160.00 LF	24,176	3,796	96,000	0	123,972	774.82
B MIL 1	<02228 0322 >	lean concrete for culverts and		9.79	3.50	75.00	0.00	88.29	
		"U" channel pads	400.00 CY	3,917	1,400	30,000	0	35,317	88.29
B MIL 1	<02215 2460 >	foundation bedding material for		5.53	2.02	10.00	0.00	17.55	
		box culverts 6" deep	50.00 CY	277	101	500	0	878	17.55
	TOTAL	Twin 5"x10' concrete box culvert	1.00	28,370	5,297	126,500	0	160,166	160166
M MIL 1	<02762 2060 >	Piping, drainage & sewage, 36"		42.12	9.04	45.90	0.00	97.05	
		dia, RCP, class 3, no gaskets	90.00 LF	3,791	813	4,131	0	8,735	97.05
	TOTAL	36" diameter RCP	1.00	3,791	813	4,131	0	8,735	8734.86
B MIL 1	<03491 0010 >	11' x 20' concrete "U" drainage		113.32	17.79	700.00	0.00	831.12	
		channel panel	750.00 LF	84,994	13,344	525,000	0	623,337	831.12
	TOTAL	11' x 20' concrete "U" channel	1.00	84,994	13,344	525,000	0	623,337	623337
	TOTAL	Water Control	1.00	914,590	214,736	1,531,957	0	2,661,283	2661283
M RSM 1	<01533 0010 >	Barricades, cones and barrels		31.74	0.00	8.00	0.00	39.74	
		for lane assignment	120.00 LF	3,809	0	960	0	4,769	39.74
	TOTAL	Barricades	1.00	3,809	0	960	0	4,769	4768.69
CIV 1	<02840 2000 >	Jersey barrier, 2' wide, 3'-6"		7.98	0.69	29.67	0.00	38.34	
		H, sgl, precast conc, barrier	320.00 LF	2,554	220	9,494	0	12,268	38.34
L AF 1	<02840 0160 >	Guide/guard rail, wood posts		4.64	0.36	11.02	0.00	16.02	
		6'3" OC, w/ corr galv steel rails	800.00 LF	3,710	287	8,816	0	12,812	16.02

K3.69. Additional Barriers & Guardrail		QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
B AF 1 <02840 0160 >	Demo existing guard rail		19.00	1.47	0.00	0.00	20.47	
	rails	30.00 LF	570	44	0	0	614	20.47
	TOTAL Additional Barriers & Guardrail	1.00	6,834	550	18,310	0	25,694	25694
AF 1 <01580 0010 >	Sign, hi-intensity		0.00	0.00	13.98	0.00	13.98	
	reflectorized, no posts, buy	100.00 SF	0	0	1,398	0	1,398	13.98
	TOTAL Signage	1.00	0	0	1,398	0	1,398	1398.00
MIL 1 <01036 0770 >	Field personnel, security		5172.41	0.00	0.00	0.00	5172.41	
	officer	6.00 MO	31,034	0	0	0	31,034	5172.41
	TOTAL Police Detail	1.00	31,034	0	0	0	31,034	31034
B MIL 1 <02266 1110 >	Erosion control, fence only,		2.32	0.00	2.50	0.00	4.82	
	silt fence, 3' high, w haybales polypropylene	820.00 LF	1,901	0	2,050	0	3,951	4.82
	TOTAL Erosion Control	1.00	1,901	0	2,050	0	3,951	3950.84
B RSM 1 <02144 1000 >	Wellpoint system for 4-7 months		197.67	0.00	110.00	0.00	307.67	
		1800.00 LF	355,810	0	198,000	0	553,810	307.67
	TOTAL Well Points	1.00	355,810	0	198,000	0	553,810	553810
B MIL 1 <02505 0813 >	Bituminous conc pavement, 2.5"		14.67	3.00	7.00	0.00	24.67	
	base, 1.5" wearing	1430.00 SY	20,978	4,290	10,010	0	35,277	24.67
	TOTAL Bituminous Conc. Pavement	1.00	20,978	4,290	10,010	0	35,277	35277
MIL 1 <03217 0600 >	Reinforcing in place, slab on		1177.74	0.00	525.66	0.00	1703.40	
	grade, #3 to #7	5.00 TON	5,889	0	2,628	0	8,517	1703.40
MIL 1 <03154 0100 >	Forms in place, eqpt		14.03	0.00	1.03	0.00	15.06	
	foundations, 3 use	2000.00 SF	28,057	0	2,060	0	30,117	15.06
B RSM 1 <03326 0100 >	Concrete ready mix, regular		100.00	20.00	85.00	0.00	205.00	
	weight, 4500 psi	70.00 CY	7,000	1,400	5,950	0	14,350	205.00
MIL 1 <03396 0150 >	Finishing floors, monolithic,		0.94	0.00	0.00	0.00	0.94	
	broom finish	2000.00 SF	1,883	0	0	0	1,883	0.94

K3.IP. Construct Boat Ramp		QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
M MIL 1 <02270 1000 >	Rip-rap, random pieces, dumped from truck, 3/8 - 1/4 CY		28.13	5.23	30.00	0.00	63.36	
		800.00 CY	22,502	4,185	24,000	0	50,687	63.36
M MIL 1 <02244 0300 >	Base course, crushed 3/4" stone, compacted, 12"D, large areas		0.56	0.33	12.00	0.00	12.90	
		800.00 SY	452	266	9,600	0	10,318	12.90
	TOTAL Construct Boat Ramp	1.00	65,783	5,851	44,238	0	115,872	115872
B MIL 1 <02511 0020 >	Bituminous concrete paved walkways, incl base material pass,fnsh&curing		19.36	2.89	20.00	0.00	42.25	
		700.00 SY	13,550	2,023	14,000	0	29,573	42.25
	TOTAL 7' wide bit con. walkway	1.00	13,550	2,023	14,000	0	29,573	29573
M MIL 1 <05523 0950 >	Railing, pipe, steel, 2 rail, primed, 2" dia, on brackets		11.39	0.23	9.00	0.00	20.62	
		1600.00 LF	18,220	366	14,400	0	32,986	20.62
	TOTAL Safety Railing	1.00	18,220	366	14,400	0	32,986	32986
B MIL 1 <02525 0550 >	concrete curb, precast, 6" x 18", straight		7.45	0.64	10.00	0.00	18.09	
		800.00 LF	5,958	513	8,000	0	14,470	18.09
	TOTAL Concrete Curb	1.00	5,958	513	8,000	0	14,470	14470
	TOTAL Sitework and Traffic Control	1.00	523,876	13,592	311,367	0	848,835	848835
L MIL 1 <02215 2360 >	Backfill, spread dumped gravel/fill, dozer, 6" layers, light compaction.		2.42	1.50	0.00	0.80	4.72	
		260.00 CY	629	390	0	208	1,227	4.72
CIV 1 <02250 2130 >	Geotextile fabric, 60 mil thick, non-woven polypropylene		0.83	0.08	0.60	0.00	1.51	
		612.00 SY	506	49	367	0	922	1.51
L AF 1 <02215 2500 >	Haul and dump gravel to build temp road.		3.23	1.18	0.00	0.00	4.41	
		260.00 CY	839	306	0	0	1,145	4.41
	TOTAL Construct Temporary Road	1.00 EA	1,974	745	367	208	3,295	3294.59
L MIL 1 <02232 0145 >	Excavate & load, hydr excavator, 2 CY, wet matl		8.70	4.63	0.00	0.00	13.33	
		741.00 CY	6,450	3,428	0	0	9,877	13.33
	TOTAL Excavate Sediment	1.00 EA	6,450	3,428	0	0	9,877	9877.38

L1.15. Place Sediment on Bank	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
L AF 1 <02215 2500 > Haul, dump and spread excavated material on shorline.	741.00 CY	3.23 2,391	1.18 873	0.00 0	0.00 0	4.41 3,264	4.41
TOTAL Place Sediment on Bank	1.00 EA	2,391	873	0	0	3,264	3264.40
L MIL 1 <02232 0140 > Excavate & load, hydr excavator, 2 CY, medium matl	260.00 CY	3.05 792	1.62 421	0.00 0	0.00 0	4.66 1,213	4.66
L MIL 1 <02234 0340 > Hauling, hwy haulers, 12 CY, 1 mi round trip @ 20 MPH (4.2 cyc/hr)	260.00 CY	2.60 675	1.97 512	0.00 0	0.00 0	4.56 1,186	4.56
TOTAL Remove Temporary Road	1.00 EA	1,467	933	0	0	2,399	2399.23
L MIL 1 <02234 0545 > Hauling, hwy haulers, 12 CY, 6 mi round trip @ 40 MPH, assume two truck loads, no disposal fee included, assume composting.	24.00 CY	7.42 178	5.62 135	0.00 0	0.00 0	13.04 313	13.04
B MIL 1 < > Outside Laborers, (Semi-Skilled) power brush cut fragmites, bag and load in truck. Treat each individual stem with herbicide.	36.00 HR	42.65 1,535	0.00 0	4.00 144	0.00 0	46.65 1,679	46.65
TOTAL Remove Fragmites	1.00 EA	1,713	135	144	0	1,992	1992.31
B MIL 1 <02932 0340 > Seed shoreline area with switch grass,. Install seed with push spreader and lightly rack into soil. Soil used will be the excavated sediment that is placed and spread on shroe line.	9.00 CSY	15.43 139	0.00 0	24.00 216	0.00 0	39.43 355	39.43
MIL 1 < > Laborers, (Semi-Skilled) rake seed into soil and install erosion control mulch hay to prevent erosion.	16.00 HR	52.16 835	0.00 0	0.00 0	0.00 0	52.16 835	52.16
L MIL 1 <02951 0760 > Mulch, pine straw, 1" deep, hand spread	8000.00 SF	0.21 1,712	0.00 0	0.08 640	0.00 0	0.29 2,352	0.29
TOTAL Seeding	1.00 EA	2,685	0	856	0	3,541	3541.38

L1.35. Mob and Demob	QUANTY UOM	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
AF 1 <01580 0010 > Sign, hi-intensity reflectorized, no posts, buy	72.00 SF	0.00 0	0.00 0	13.98 1,007	0.00 0	13.98 1,007	13.98
B RSM 1 <01533 0010 > Wood. movable saw horse barriers	400.00 LF	3.32 1,329	0.00 0	3.00 1,200	0.00 0	6.32 2,529	6.32
MIL 1 < > Laborer, (Semi-Skilled) mobilization labor and equipment moves.	60.00 HR	52.16 3,129	0.00 0	0.00 0	0.00 0	52.16 3,129	52.16
MIL 1 <01036 0640 > Field personnel, surveyor	0.20 MO	10582 2,116	0.00 0	0.00 0	0.00 0	10582.07 2,116	10582
MIL 1 <01036 0640 > Field personnel, surveyor	0.20 MO	10582 2,116	0.00 0	0.00 0	0.00 0	10582.07 2,116	10582
MIL 1 < > Laborer, (Semi-Skilled) demobilization labor and equipment moves.	60.00 HR	52.16 3,129	0.00 0	0.00 0	0.00 0	52.16 3,129	52.16
TOTAL Mob and Demob	1.00 EA	11,820	0	2,207	0	14,027	14027
B CIV 1 <05912 0140 > Steel and wood tidal stoplog for 36"culvert. Will have removable boards and board storage compartment.	1.00 EA	2409.48 2,409	372.45 372	1700.00 1,700	0.00 0	4481.93 4,482	4481.93
B CIV 1 <05912 0140 > Reinforced concrete and wood board stoplog for twin 11'x20' reinforced concrete U channel. Will have removable boards and will have a board storage compartment. No design done at this time.	1.00 EA	7099.85 7,100	1097.47 1,097	4500.00 4,500	0.00 0	12697.32 12,697	12697
TOTAL Culvert Stoplogs in Pond	1.00 EA	9,509	1,470	6,200	0	17,179	17179
TOTAL Excavate Pond/Create Fish Hole	1.00	38,010	7,584	9,774	208	55,576	55576
TOTAL Run Pond Alt 4 conc."U" channel	1.00 EA	1981818	394,345	1,909,353	3,292	4,288,808	4288808

APPENDIX E. REAL ESTATE REPORT

NEW ENGLAND DISTRICT
U.S. ARMY CORPS OF ENGINEERS
699 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

Appendix E

DRAFT REAL ESTATE PLANNING REPORT

RUN POND AQUATIC HABITAT RESTORATION STUDY

YARMOUTH, MASSACHUSETTS

PREPARED BY:

A. Mary Dunn

A. MARY DUNN
STAFF APPRAISER

1.0 PURPOSE and ALTERNATIVES:

The purpose of this project is the aquatic restoration of Run Pond, aka Crowell Pond. This investigation was authorized under Section 206 of the Water Resources Development Act of 1996 (PL 104-303) entitled "Aquatic Ecosystem Restoration." As the recommended improvements are within the cost limitations of Section 206 of the Water Resources Development Act of 1996, implementation is being recommended under this authority. Run Pond is located in the southeast corner of Yarmouth, Barnstable County, on Cape Cod, Massachusetts. Its tidal inlet is to Nantucket Sound, near the mouth of the Bass River. The pond, owned by the town, is located across the street from the town beach (Bass River Beach) and town pier that are accessed from South Shore Drive. Historically, a meandering tidal creek fed the area. However, as a result of development between the site and the ocean, the creek was routed through a culvert that runs about 900 feet from Nantucket Sound, under South Shore Drive, to the pond. However, the pipe is not large enough, resulting in a restriction of the tidal flow and drainage at the site. Since the pond is not adequately flushed, there is an algae mat on the surface of the pond that contributes to the foul smell in the area; also, *Phragmites australis* a non-native and invasive species has partially invaded the salt marsh that was formerly dominated by *Spartina*. If nothing is done to improve the flow conditions of the site, the area will continue to degrade. The four alternatives that were considered for this project are discussed below.

Alternative 1: No action. Under this alternative, the wetland would continue to become more degraded.

Alternative 2: Add a new 48-inch diameter culvert to flush the pond. This is in addition to the existing 36-inch culvert. The underground pipe would go from Nantucket Sound, under the Bass River parking lot and South Shore Drive, and come out near the existing culvert on the Run Pond side (westerly) of South Shore Drive. About 300 feet of the existing 36-inch culvert will be relocated near the proposed 48-inch culvert at the Nantucket Sound end. This would bring up the water elevation and improve the flushing action by bringing more salt water into the pond as well as increase the fish and wildlife population. In addition, self-adjusting floodgates will also be installed at the Nantucket Sound end to prevent flooding in the area.

This alternative will require a permanent easement over the area where the new 48-inch culvert and relocated portion of the 36-inch culvert are located and the area between South Shore Drive and the pond, about 150 square feet (SF) of land adjacent to the pond to be used during construction and for future maintenance.

In addition, 0.5 acres of the pond will be dredged for fish habitat and for eradication of phragmites. The pipeline covers approximately 49,400 square feet (SF) of land. A temporary easement will also be required for the storage of equipment and supplies during the (6) six-month construction phase, over approximately 146,350 SF of land. Construction will be during the off-season to prevent interference with the visitors to Bass River Beach and the boat ramp and prevent any loss in revenue to the town from parking fees. One private landowner and the town of Yarmouth own the land required for this option.

The real estate costs for this alternative are as follows:

Permanent easement area, 49,550 SF of land =	$ 89,190
Temporary easement area, 146,350 SF of land, 6 months	$ 65,858
Contingency, 25% =	$ 38,761
Acquisition costs, 2 ownerships =	$ 10,000
Total real estate costs, rounded	$205,000

Alternative 3: This alternative would add twin 5-feet by 10-feet box culverts in addition to the 36-inch diameter pipe currently there. The underground pipe would go from Nantucket Sound, under the Bass River parking lot and South Shore Drive, and come out near the existing culvert on the Run Pond side (westerly) of South Shore Drive. About 300 feet of the existing 36-inch culvert will be relocated near the proposed twin culverts at the Nantucket Sound end. This would bring up the water elevation and improve the flushing action by bringing more salt water into the pond as well as increase the fish and wildlife population. In addition, 0.5 acres of the pond will be dredged for fish habitat and for eradication of phragmites. Self-adjusting floodgates will also be installed at the Nantucket Sound end to prevent flooding in the area.

This alternative will require a permanent easement during construction and for future maintenance over the area where the twin 5-feet by 10-feet culverts and the relocated portion of the 36-inch culvert are located (easterly of South Shore Drive) and the area between South Shore Drive and the pond, covering 72,650 SF of land. A temporary easement will also be required during the construction phase, about 6 months, over approximately 123,300 SF of land, covering a strip of land on either side of the pipelines and the area where the equipment and supplies will be stored. Two private landowners and the town of Yarmouth own the land area required for this option. Construction will be during the off-season to prevent interference with the visitors to Bass River Beach and prevent any loss in revenue to the town from parking fees.

The real estate costs for this alternative are as follows:

Permanent easement area, 72,650 SF of land =	$130,770
Temporary easement area, 123,300 SF of land =	$ 55,485
Contingency, 25% =	$ 46,564
Acquisition costs, 3 ownerships =	$ 15,000
Total real estate costs, rounded	$250,000

Alternative 4: This alternative has an open channel from Narraganset Bay to Run Pond. This would consist of creating a 20-foot wide by about 900-foot long open channel on the northerly side (at the boundary of the residential house lots) of the town parking area that would go under South Shore Drive and come out on Run Pond near the existing 36-inch culvert. The self-adjusting tide gates would be installed on the easterly side of South Shore Drive at the point where the culvert begins. The existing boat ramp would be demolished and relocated on the southerly side of the open channel. The existing 36-inch pipe would remain. This option would eliminate a minimum of 190 parking spaces at the 11-plus acre town parcel utilized as a town parking lot and boat ramp.

This alternative would require the fee acquisition of 16,400 SF of land for the open channel (the town already owns this land) a permanent easement over 59,850 SF of land on the westerly side of the proposed channel for future maintenance, about 150 SF of land area between South Shore Drive and the pond, to be used during construction and for future maintenance, the area needed for the relocation of the boat ramp, as well as the land on the westerly side of South Shore Drive where the culverts are located, and a temporary easement over 122,900 SF of land for six (6) months, during the construction phase. Construction will be during the off-season to prevent interference with the visitors to Bass River Beach and prevent any loss in revenue to the town from parking fees. Three private landowners and the town of Yarmouth own the land required for this option.

The real estate costs for this option are as follows:

Fee acquisition, 16,400 SF of land =	$147,600
Permanent easement, 60,000 SF of land =	$108,000
Temporary easement, 122,900 SF of land =	$ 55,305
Contingency, 25% =	$ 77,726
Acquisition costs, 4 ownerships =	$ 20,000
Total real estate costs, rounded	$410,000

2.a. PROJECT AREA DESCRIPTION:

Access to Run Pond is from South Shore Drive. The area immediately adjacent to the pond is improved with house lots or unimproved land. There are two commercial motels across the street from the pond on South Shore Drive, one is the Smugglers' Beach Ocean Club, a time-share motel located adjacent to the town parking lot, and the other is the Riviera Club motel located adjacent to the Smugglers' Beach Ocean Club. On the other side of the town parking lot is a 3-plus acre residential lot which has been recently subdivided into two house lots (one is dog-legged lot) and developed. The town shows the entire area as being in the Residential Zoning District, therefore, the two motels are a pre-existing non-conforming use. The town owns an 11.08-acre parking lot and boat ramp located between the time-share motel and residential house lots. Any new development in the area would have to conform to current residential zoning.

2.b. RECOMMENDED PLAN: The plan recommended by the Corps of Engineers is Alternative 2. This will require the acquisition of a permanent easements over 49,400 SF of land and a temporary easement over 146,350 SF of land during the construction phase, estimated to be 6 months.

2.c. OWNERSHIPS: The land required for this project is under two ownerships. The town owns the 11-plus acres parking area where the culvert will be located and the adjacent land area needed during the construction phase and the area needed for equipment and supply storage. The area adjacent to Run Pond is owned by the owners of the motel. The motel owners utilize this area next to the pond for excess parking.

3. DESCRIPTION OF NON-FEDERAL SPONSOR'S EXISTING OWNERSHIP:

The town of Yarmouth is the non-federal sponsor for this project. The town owns most of the land required for this project including the pond, access to the pond, land required for the installation of the underground pipes, and the land needed for a staging area construction phase. The town will acquire a permanent easement over about 150 SF of the small parking area west of South Shore Drive that is owned by the motel for construction and future maintenance.

4. RECOMMENDED ESTATES:

Estates are as stated in "Estates" ER 405-1-12 of the Real Estate Handbook, Chapter 5. The estate that will be utilized for this project is Estate No. 15 – Temporary Work Area Easement and a Permanent Access Easement, the language for this easement will be forwarded to USACE for approval.

5. EXISTING FEDERAL PROJECTS:

There are no current projects in the project area.

6. EXISTING FEDERAL OWNERSHIPS:

An inspection of the area indicated no Government-owned facilities are affected by this project.

7. NAVIGATION SERVITUDE:

Navigation servitude does not apply.

8. REAL ESTATE MAPPING:

Maps identifying the land area required for the project will be developed during plans and specs phase.

9. INDUCED FLOODING:

No induced flooding is anticipated as a result of the proposed project. Since it is proposed to install floodgates as part of this project, the flooding will be reduced.

10. BASELINE COST ESTIMATE FOR REAL ESTATE:

Fee Value: No fee acquisition is anticipated.

Permanent Easement Area: A permanent easement will be required over 49,400 square feet of land located on the town of Yarmouth parking lot and boat launching area and the parcel adjacent to Run Pond.

Temporary Easement Areas: Temporary easements will be required during the construction period, estimated to be six months and during the off-season, over approximately 146,350 square feet of land. Most of the land is located east of South Shore Drive and is owned by the town.

Administrative Costs: There will be administrative costs associated with these acquisitions such as title work, mapping, and closing. These costs are estimated to be $5,000 per ownership or $10,000.

The cost estimate for real estate will be as follows:

Fee Acquisition	$ 0
Permanent Easements	$ 88,920
Temporary Easements	$ 65,858
Contingency, 25%	$ 38,694
Acquisition Costs, 2 owners @ $5,000	$ 10,000
Total Estimated Real Estate Costs, rounded	**$205,000**

11. PUBLIC LAW 91-646 RELOCATIONS:

The local sponsor supports the project and has been advised that the requirements of PL 91-646 must be followed in the acquisition of real estate for project purposes and has also been informed about Corps acquisition policies and procedures, LERRD crediting procedures, and HTRW responsibilities for land acquisition. There are no potential Public Law 91-646 relocations required in connection with this project.

12. MINERAL/TIMBER ACTIVITY:

There is no present or anticipated mineral or timber harvesting activity in the vicinity of the project.

13. ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITIES:

The non-federal sponsor is the town of Yarmouth, Massachusetts. Some of the land required is owned by a private landowner, however, most of the lands required for this project are under town ownership. The town of Yarmouth has real estate acquisition and eminent domain authorities in the project area. The *Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability* is attached.

14. ZONING CHANGES: No zoning changes are proposed in lieu of, or to facilitate, real estate acquisitions.

15. ACQUISITION SCHEDULE:

The town of Yarmouth has the capability to complete the project within the designated milestone time period, anticipated to be 2 years. The Real Estate Acquisition schedule is shown below:

a. PCA execution	November 2008
b. Forward maps to sponsor	November 2008
c. Survey	November 2008
d. Title	January 2009
e. Appraisals	January 2009
f. Closings	May 2009
g. Possession	May 2009

16. FACILITIES AND UTILITIES RELOCATIONS:

The proposed project will not require any utility and/or facility relocations.

17. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE:

There is no known on-site contamination and the real estate estimates contained in this report do not reflect the presence of contamination.

18. LANDOWNER SENTIMENT:

The town of Yarmouth strongly supports the project to restore Run Pond and recognizes the benefits from both ecological and community resource aspects. The town wants to deepen the pond and remove the aquatic weeds and, thus, improve water quality and aquatic habitat.

Project Name:___RUN POND AQUATIC HABITAT RESTORATION PROJECT

Project Location:_YARMOUTH, MA

Project Sponsor:__TOWN OF YARMOUTH, MASSACHUSETTS

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY

Run Pond Aquatic Habitat Restoration Project

1. Legal Authority: -

Name and title of sponsor's representative providing answers to this section.

Karl W. von Hone, Director, Yarmouth Natural Resources Department

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes?
(yes) If yes, list the basis for the legal authority:_The General Laws of the Commonwealth of Massachusetts.
b. Does the sponsor have the power of eminent domain for this project?
(yes) If yes, list the basis for the legal authority: The General Laws of the Commonwealth of Massachusetts.
c. Does the sponsor have "quick-take" authority for this project? (no)
d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? (no)
e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? (no)

II. Human Resource Requirements:

Name and title of sponsor's representative providing answers to this section.

Karl W. von Hone, Director, Yarmouth Natural Resources Department

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended?
(yes)
b. If the answer to II. a. is "yes," has a reasonable plan been developed to provide such training? (no)
c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? (yes)
d. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? (yes)
e. Can the sponsor obtain contractor support, if required in a timely fashion?
(yes)
f. Will the sponsor likely request USACE assistance in acquiring real estate?
(no) (If "yes," provide description)

Project Name:___RUN POND AQUATIC HABITAT RESTORATION PROJECT

Project Location:_YARMOUTH, MA

Project Sponsor:__TOWN OF YARMOUTH, MASSACHUSETTS

III. Other Project Variables:

Name and title of sponsor's representative providing answers to this section.

Karl W. von Hone, Director, Yarmouth Natural Resources Department

a. Will the sponsor's staff be located within reasonable proximity to the project site? (yes)
b. Has the sponsor approved the project/real estate schedule/milestones? (no)

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? (not applicable)
b. With regard to this project, the sponsor is anticipated to be: moderately capable

(If sponsor is believed to be "insufficiently capable," provide explanation)

V. Coordination:

a. Has this assessment been coordinated with the sponsor? (yes)
b. Does the sponsor concur with this assessment? (yes) (If "no," provide explanation)

Prepared by:

A. Mary Dunn (date) 10/18/07
(signature)

Typed Name: A. Mary Dunn

Typed Title: Staff Appraiser

Reviewed and approved by:

Joseph M. Redlinger (date) 10/18/07
(signature)

Typed Name: Joseph M. Redlinger
Chief, Real Estate Division

Project Name:___RUN POND AQUATIC HABITAT RESTORATION PROJECT

Project Location:_YARMOUTH, MA

Project Sponsor:__TOWN OF YARMOUTH, MASSACHUSETTS

III. Other Project Variables:

Name and title of sponsor's representative providing answers to this section.

Karl W. von Hone, Director, Yarmouth Natural Resources Department

a. Will the sponsor's staff be located within reasonable proximity to the project site? (yes)
b. Has the sponsor approved the project/real estate schedule/milestones? (no)

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? (not applicable)
b. With regard to this project, the sponsor is anticipated to be: moderately capable

(If sponsor is believed to be "insufficiently capable," provide explanation)

V. Coordination:

a. Has this assessment been coordinated with the sponsor? (yes)
b. Does the sponsor concur with this assessment? (yes) (If "no," provide explanation)

Prepared by:

A. Mary Dunn (date) 10/18/07
(signature)

Typed Name: A. Mary Dunn

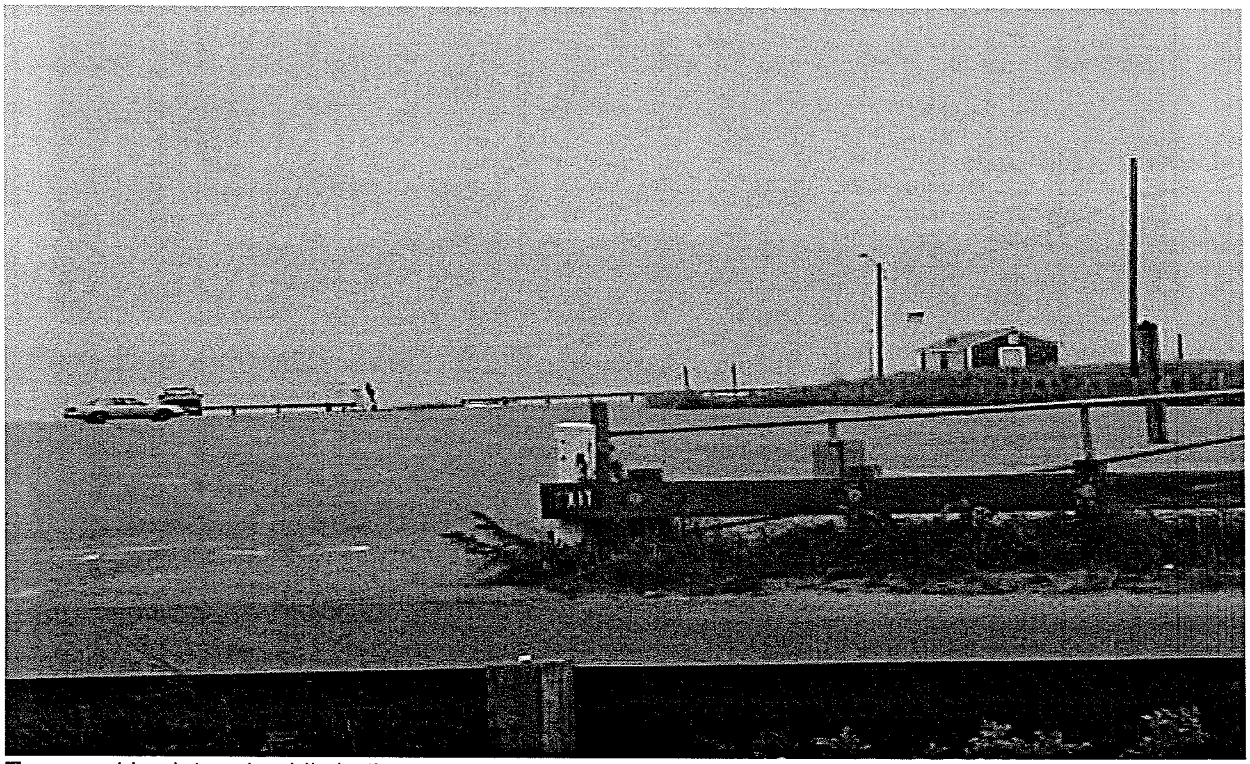
Typed Title: Staff Appraiser

Reviewed and approved by:

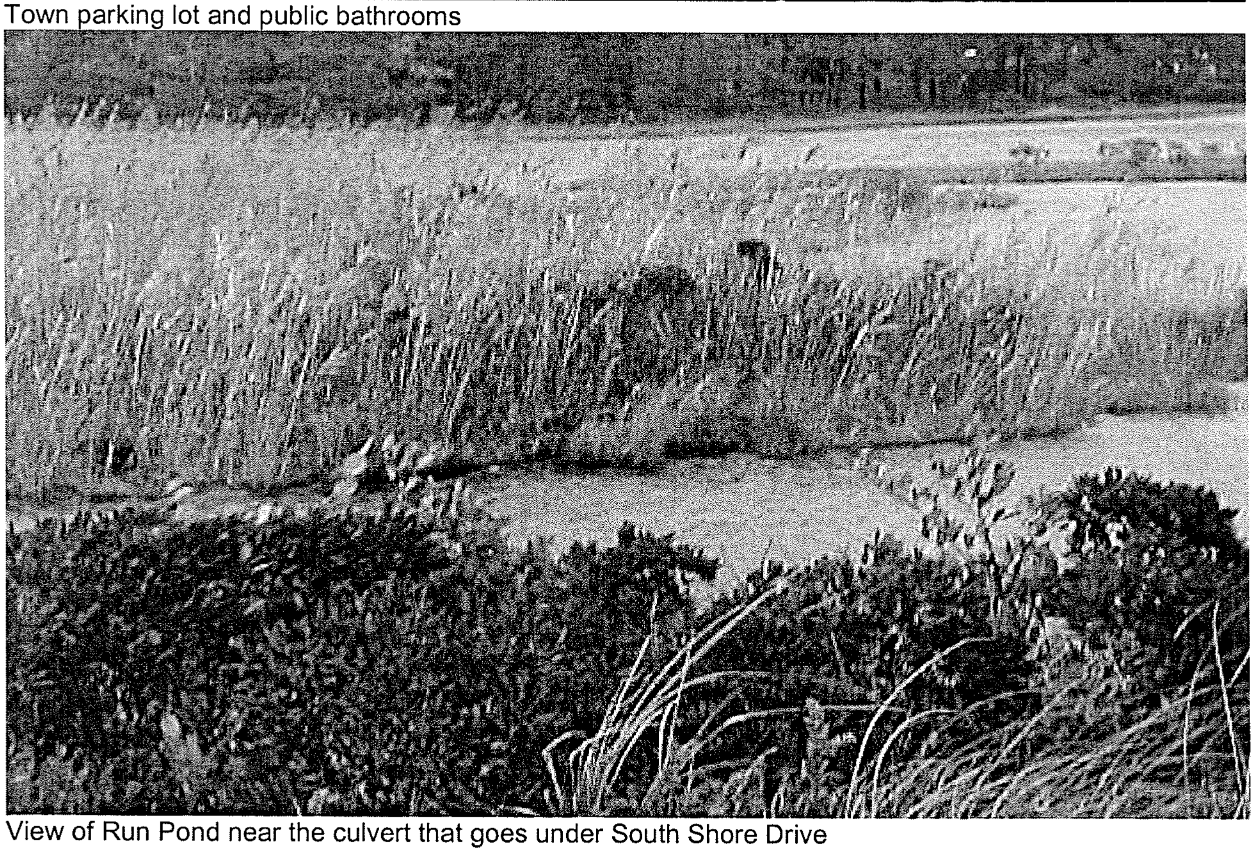
Joseph M. Redlinger (date) 10/18/07
(signature)

Typed Name: Joseph M. Redlinger
Chief, Real Estate Division

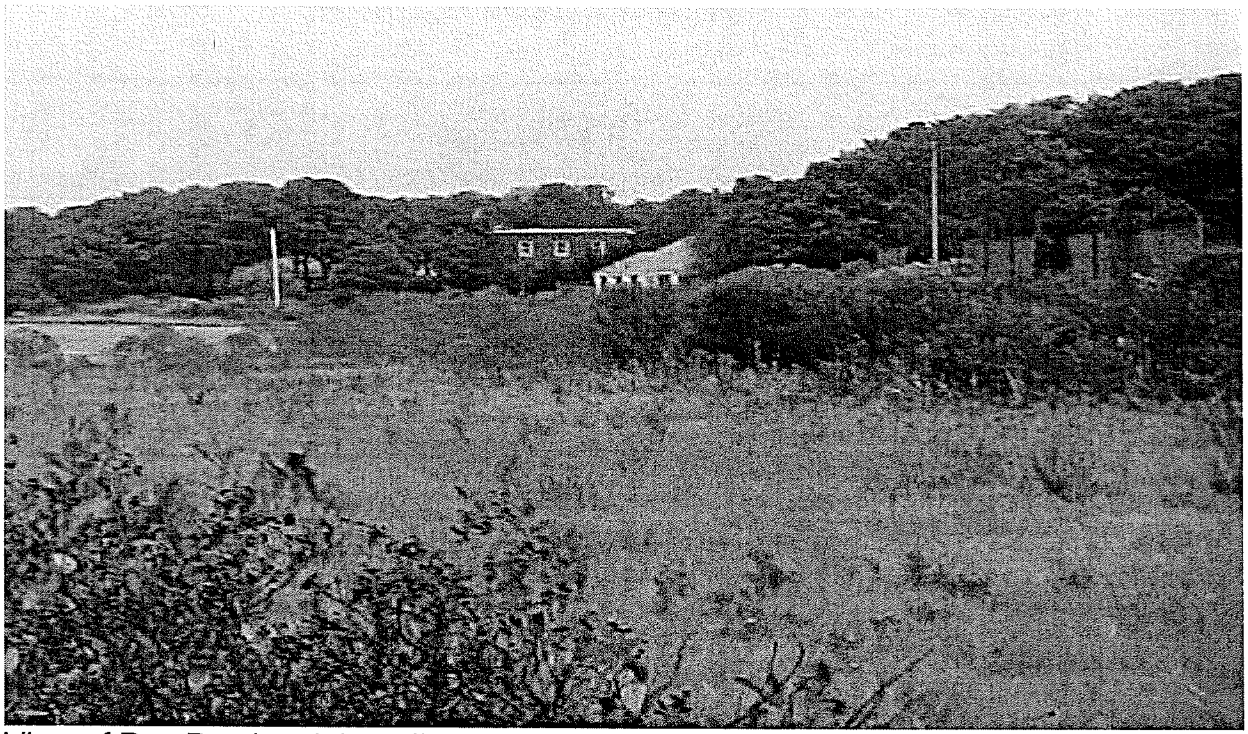
PHOTOGRAPH OF RUN POND (AKA CROWELL POND) TAKEN OCTOBER 29, 2003
BY A. MARY DUNN, STAFF APPRAISER



Town parking lot and public bathrooms

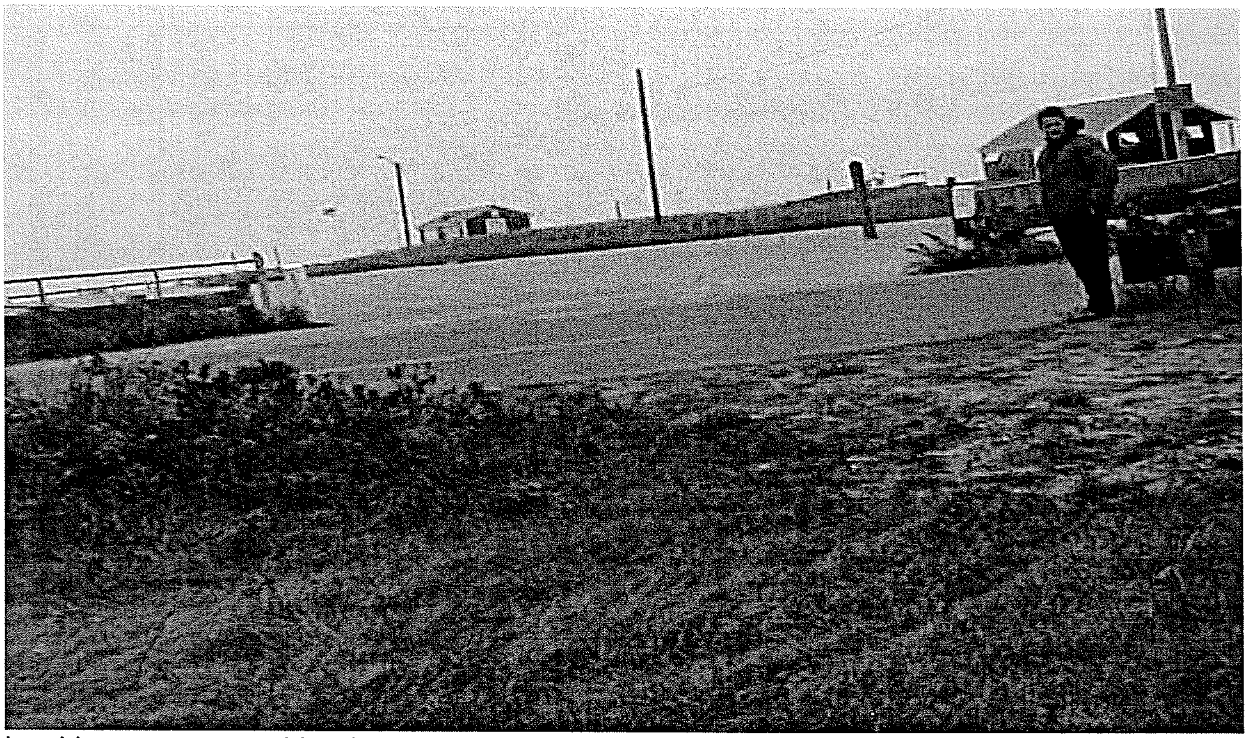


View of Run Pond near the culvert that goes under South Shore Drive



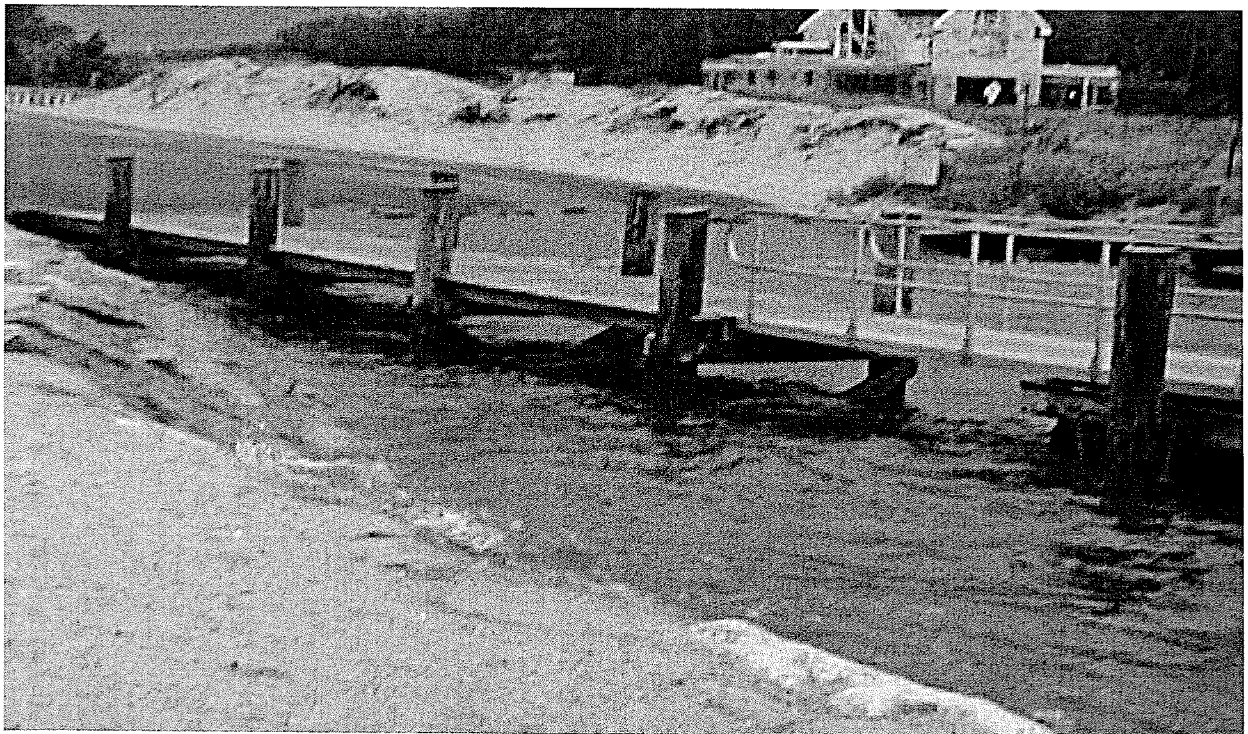
View of Run Pond and the adjacent private homes

View of hotel located adjacent to town parking lot and the area where existing 36-inch culvert comes out into Run Pond

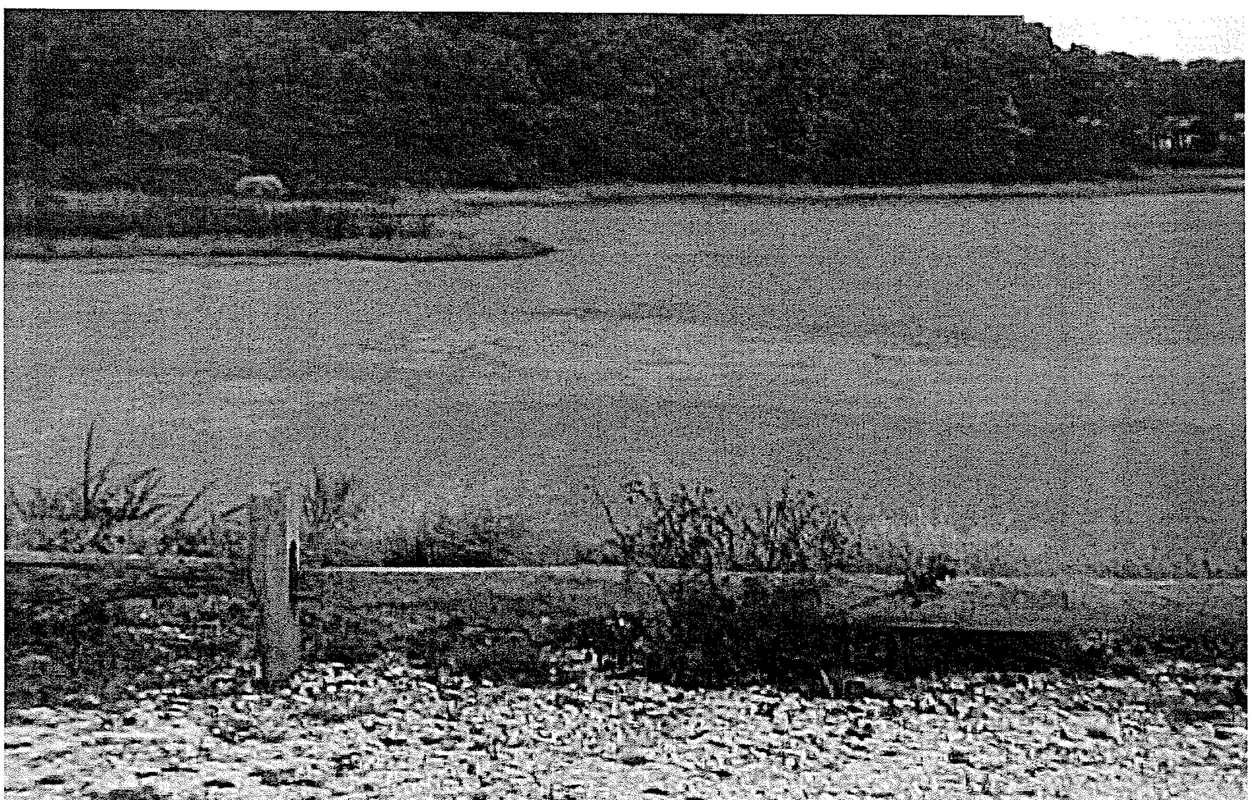


Looking at town parking lot and beach area while standing across street near Run Pond

View of 36-inch culvert opening with street and hotel across street in background

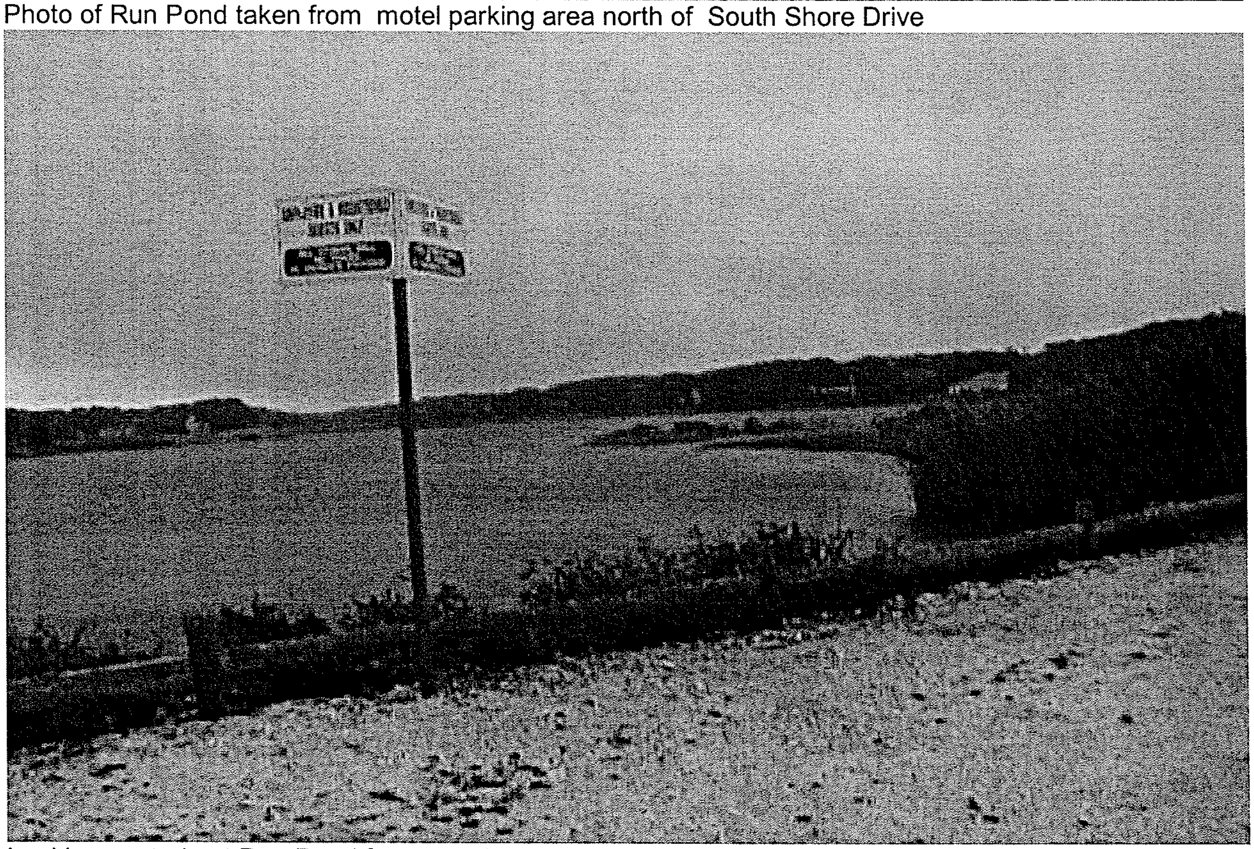


Boat ramp on easterly side of town parking area, private home being constructed on adjacent lot



Run Pond with view of algae mat floating on top and motel parking area in foreground

Photo of Run Pond taken from motel parking area north of South Shore Drive



Looking easterly at Run Pond from motel parking area north of South Shore Drive